

**„Babeş- Bolyai” University Cluj-Napoca**  
**Faculty of Geography**

**BÁLINT-BÁLINT Lóránt**

**GEOMORPHOSITES IN THE  
HARGHITA MOUNTAINS**

*PhD Thesis Abstract*

**PhD Coordinator:**

Prof. univ. dr. Ioan-Aurel Irimuş

Cluj-Napoca  
2018

# Content

INTRODUCTION.....	3
Geomorphosites in the geographic literature.....	5
MATERIALS AND METHODS.....	6
Prolong Method.....	7
Evaluation chart, authentication algorithm of the geomorphosites.....	8
Geomorphosite research on a global scale.....	14
Brief research history of the geomorphosites in Romania.....	15
Evaluating volcanic geomorphosites in the Harghita Mountains.....	17
Volcanic geomorphosite tipology.....	19
RESULTS AND DISCUSSIONS.....	21
Volcanic geomorphosites.....	21
Volcanic geomorphohydrosites.....	23
Volcanic hydrogeomorphosites.....	24
Evaluation summary of the volcanic geomorphosites in the Harghita Mountains.....	28
Touristic evaluation and marketing of the geomorphosites.....	30
CONCLUZIONS.....	36
BIBLIOGRAPHY.....	39
PhD thesis content.....	48

**Key words:** geomorphosite, geomorphohydrosite, volcanic hidrogeomorphosite, criteria, evaluation, tourism, mofette, springs, post volcanic, Harghita.

## **Introduction**

For my PhD. Thesis I chose to study the region of the Harghita Mountains for personal and scientific reasons. I was born and I live in Lazaresti, a small settlement on the south-est of the volcanic mountain chain, situated in the south of the Lower Ciuc Depression. In this respect my intention is to come to know, to study, to highlight and to point out the richness, the beauty of the results of volcanism and post volcanic phenomena in the Harghita Mountains and its surroundings.

My final graduation paper for finalizing my university studies was entitled: The tourism potential of Lazaresti village. In this paper I described the tourism potential and natural and anthropic tourism resources, the post volcanic activities noted in the region (mineral water springs, mofettas from Nyir Baths), Saint Ana volcanic Lake, Mohos Turf Bog, which are located within the administrative territory of Lazaresti. For my master's graduation paper I chose to study the Mohos Turf Bog, which is located within one of the craters of the Ciomat Mountain, entitled: The Eco touristic potential of the Mohos Turf Bog. Thus I came to research the youngest volcanic cone in Romania and its two main craters.

As my PhD thesis together with my mentor we proposed to study the Geomorphosites in the Harghita Mountains. As a support and starting point for my research I chose to study the scientific papers written by Schreiber W.E. and of my mentor Irimuş I. A: Volcanic phenomena which generated the Southern Sector, the Căliman-Gurghiu-Harghita of the Volcanic Chain of East Transylvania, which got formed in the Superior-Pliocene epoch – Quaternary Inferior Epoch and represent the final manifestations of the subsequent magmatic events. The Harghita Mountains present a unique landscape, and occupy the south-central region of Harghita County, lending its name to the county (Cocean P., et al, 2013). The regions natural and anthropic tourism potential is not very mediated or explored within the scientific community, not on local, regional or even national, international levels.

During my research I investigated and pointed out (table 4) fifty-eight volcanic geomorphosites in the area of the Harghita Mountains, and among these we selected the 8 most representative sites, and we created evaluation charts for them to be able to establish their value as geomorphosites, and their tourism value as well, I described and mapped all of

them, my discoveries bring new geologic, geomorphologic and touristic data of these geomorphosites.

The identified and described geomorphosites are located on the foothills, on the volcanic plateaus, on the volcanic cones and within of the Harghita Mountains as well as on the peripheries of the region for the reason of them being the direct result of the volcanic activities. Being located between latitudes 46.10 and 46.60 north, and the longitudes 25.45 and 29.95 east, the Harghita Mountains belong to the volcanic mountain chain Oaş – Gutâi – Tibleş – Călimani – Gurghiu – Harghita in the Eastern Carpathians.

From a spatial point of view the foothills are part of the Ciuc Depression, but according to their genesis, they belong to the Harghita Mountains, so their existence and their origins are the result of the volcanic activity of the Harghita Mountains. This is why several of the studied geomorphosites which were identified on the foothills made me set the eastern boundaries along the Olt River until Sandominic, the north-east boundary to be the one mentioned by Scriber W. E. (1994), a boundary followed by the national railway line and the national road DN12/E578 between Sandominic and Gheorgheni.

Geomorfositurile au fost identificate prin: studiul efectuat pe teren, cunoaşterea zonei şi prin analiza reliefului vulcanic pe hărţile topografice (proiecţie Gauss, scara 1 : 25 000) şi geologice (1 : 200 000), respectiv pe ortofotoplanuri (2005); pe hărţile topografice (proiecţie Gauss, scara 1: 25 000) am realizat analiza morfometrică şi morfologică a reliefului vulcanic, cartografierea terenului, iar utilizând harta geologo - geomorfologică, inventarierea geomorfositurilor şi identificarea regiunilor vulnerabile la procese naturale şi antropice.

The geomorphosites were identified with: direct research in the field, knowing the area and analyzing the volcanic relief on the topographic maps (using the Gauss-Krueger projection system on the 1:25,000 scale) and geological maps (1:200,000 scale), on ortophotoplans (2005). On these maps we made the morphometric and morphologic analysis of the volcanic landscape, the cartography of the landscape, and finally creating the inventory of the geomorphosites and identifying the vulnerable regions to the natural and anthropic processes.

The genetic and evolutionary characteristics of the post-volcanic activities are at the origin of our classification of the geomorphosites: volcanic geomorphosites, geomorphohydrosites and volcanic hydro-geomorphoties. For the territory of the Harghita Mountains, the following maps were created: geological map, the map of land usage, lithological map, altitude map and representation of the geomorphosites, , and for the eight

geomorphosites elevation maps, fragmentation depth of the relief maps, the density of fragmentation, slope exposition maps, slope maps, geological maps, litologic maps and geotouristic maps. The next phase of the thesis consists in the evaluation of the scientific, landscape value, of the cultural hystoric value, of the educational and pedagogic value, of the social and economic values of the geomorphosites, geomorphohydrosites and volcanic hydrogeomorphosites.

The researches result permitted us to create the inventory of the volcanic geomorphosites and creating the geomorphologic heritage of the area, summing up the natural and anthropic tourism resources, to raise public awareness on these forms of the relief which we consider should become protected areas, thus providing necessary information for the promoting of these values at a national and international level, to be able to include it into the regional national and international tourism circuit.

However the study reveals the role of the natural and anthropic resources in sustaining a territory with a poorly diversified economy, in general axed on agriculture and tourism, with an increased rate of unemployment and showing serious signs of demographic aging and with high rates of emigration among the young age groups.

The geomorphosites from the Harghita Mountains can be marketed through different forms of tourism, geotourism, ecotourism, scientific tourism, educational tourism, cultural tourism, religious tourism, spa-wellness tourism , sport tourism, leisure tourism. Thus they can contribute to the social-economic development of this geographic space, and last but not least to the creation of a geopark within the Harghita Mountains, which has all the necessary components.

## **GEOMORPHOSITES IN THE GEOGRAPHIC LITERATURE**

Geomorphosites can be considered as geological areas, which can be defined as parts of the geosphere, which present a unique importance in understanding of the Earth's history. These are delimited in space and in a scientific point of view from the surrounding area. Different groups of geosites can be defined according to their scientific interest in three groups: paleonthologic, hydrogeologic and sedimentologic.

The structural sites of geomorphologic interest are named geomorphosites and they present two levels of differentiation: a restrictive definition – which considers geomorphosites as witnesses of the history of Earth; and a larger more open definition, which considers that

geomorphosites are those aspects of the relief which can be graded according to five important values: scientific, ecologic, esthetic, cultural and economic. It was proposed that the first value to be a base value and the other four are additional values.

Geomorphosites are forms of the relief or geomorphologic processes which in time gained an esthetic, scientific, cultural. Historic or economic value due to the human perception (Panizza, 2001 cited by Laura Comănescu, 2009).

The term “Geomorphosite” – proposed by M. Panizza in 2001 – which is utilized on a wide scale in the geomorphologic community to qualify a part of the relief which is part of the geomorphologic heritage.

The last two decades considers others terms with similar use in the geographic literature:

- **Geomorphologically Active** (Panizza E: Piacente 1993 Quaranta 1993): the authors propose two types of evaluations: an esthetic one (intuitive) and a unique one (more argumentative and qualitative).
- **Geomorphological goods** (Carton et al 1994): the authors propose the evaluation of the geomorphologic goods according to four values: scientific, esthetic, cultural and economic. The scientific value is obtained according to five characteristics: the representativeness of the geomorphologic evolution, being an example in education, paleogeographic remnant, environmental rarity and ecological value.
- **Geomorphological sites** (Hooke 1994): the author refers to the dynamics of the geomorphosites. He proposes three main interests: observing the active processes, esthetic value and ecologic value.
- **Geomorphologic geotops** (Grandgirard 1995, 1997, 1999) according to the author the value of the geotops is determined by their scientific value.
- **Sites of geomorphologic interest** (Rivas et al., 1997): according to the author the sites can be defined based on their scientific, educational or recreational interest.
- **Geomorphosite** (Panizza 2001): “A geomorphosite is a form of the relief to which we can attribute a value.”

## MATERIALS AND METHODS

Studying the specialty literature and methodologies of evaluation proposed by the different authors lead me to the conclusion that the Pralong method completed by Gabliella Cocean (2011), Bianca Toma (2012) and Irimia D.N. (2016), which I adopted for the volcanic

geomorphosites, is the most appropriate one for this study, because besides the general value of the geomorphosites emphasizes their touristic value as well.

The volcanic geomorphosites from the Harghita Mountains are partially known in the mountainous tourism area of Romania (Irimuş, I.A. & Balint-Balint L. et al. 2015).

## PRALONG METHOD

This method was developed by Pralong in 2005, which evidences the general value of the geomorphosites along their touristic value, the accent being placed on the touristic value.

**Touristic value** of the geomorphosites is the result of average value of the landscape or its esthetic value ( $V_{sce}$ ), scientific value ( $V_{sci}$ ), cultural-hystoric value ( $V_{cult}$ ) and social-economic value ( $V_{eco}$ ). The author specifies that they all have the share in contributing to the gross value, this being justified by the lack of real motivation that either of them being more important then the others (Gabriela C. 2011).

$$V_{tour} = (V_{sce} + V_{sci} + V_{cult} + V_{eco}) / 4$$

When evaluating the **landscape value** of the geomorphosites the total number or overlooks is considered, the average distance between them, the surface of the geomorphosite, its altitude and chromatic contrast. The **esthetic value** is measured as the average of these values, being graded between 0 and 1. The **scientific value** is represented by the paleogeographic interest, representativeness, the surface of the site in percentage from the total surface of all similar sites, its rarity, integrity and ecologic interest. The way in which these factors, being noted as  $Sci_{1,2,3,4,5,6}$  participate in the grading of the scientific value is different, the importance of the surface and rarity are reduced by half just as we can see in the formula (Gabriela Cocean, 2011):

$$V_{sci} = (Sci_1 + Sci_2 + 0,5 \times Sci_3 + 0,5 \times Sci_4 + Sci_5 + Sci_6) / 5$$

**Cultural value** is calculated based on some criteria: cultural and historic habits, representativeness in arts, the presence of archeological discoveries, religious relevance, folk beliefs and cultural-artistic events (Bianca Toma, 2012).

It is remarked the unequal contribution of the different factors (G.Cocean, 2011):

$$V_{cult} = (Cult1 + 2 \times Cult2 + Cult3 + Cult4 + Cult5) / 6$$

**The economic value** is calculated as the average of the accessibility, natural risks, the annual number of visitors, the average level of protection and the expressed level of attraction (Gabriela Cocean, 2011).

Evaluation the value of exploitation of the geomorphosites is calculated by adding up the values of exploitation ( $V_{deg}$ ) and the methods of exploitation ( $V_{mod}$ ).

$$V_{exp} = V_{deg} + V_{mod}$$

The level of exploitation is represented by the average of the total surface, the number of the infrastructure, of the seasonal occupancy and the number of hours it is being used in a day. The method of exploitation is expressed in the percentage of exploitation of the landscape, scientifically, in a cultural and economic way. Considering the touristic evaluation of the geomorphosites, the method is well structured, but for a more complex evaluation some geomorphological criteria are missing from the scientific value (Bianca Toma, 2012).

#### **FIȘA DE EVALUARE -**

#### **ALGORITM DE AUTENTIFICARE AL GEOMORFOSITULUI**

The evaluation chart taken after Bianca Toma (2012) and completed with geomorphologic elements which define the volcanic geomorphosites, consists of four sections:

- In the first section are presented **the general data of the geomorphosites**; their name, their identification code used for inventory purposes, their position in the area and the administrative units, the typology of the geomorphosite, its extension and a photo image. All these present in brief the main characteristics of the geomorphosites. In this section are noted the values resulted from the valuation phase of the geomorphosites.
- In the second section of the chart are evaluated the **structural values ( $V_{st}$ )** of the geomorphosites, namely their geomorphologic value, esthetic value and ecologic value. They are called structural values because they have to do with the physiognomy of the sites.



- The criteria for the evaluation of these values are presented in Table Nr.1. (these values were graded between 0 and 1 with five indicators to offer them quantitative value as well).

**Table nr.1. CRITERIA IN EVALUATING GEOMORPHOSITES**

<b>Geomorphologic value (Vst1)</b>	<b>Genesis (Vst1a)</b>	1	Complex genesis, with the implication of multiple morphogenetic factors
		0,75	Genesis with the implication of at least three morphogenetic factors
		0,5	Genesis with the implication of at least two morphogenetic factors
		0,25	Genesis with the implication of a single factor
		0	Common genesis
	<b>Dynamics (Vst1b)</b>	1	Forms of the relief with accelerated dynamics
		0,75	Forms of the relief with moderate dynamics but perceptible
		0,5	Forms of the relief with a slow dynamics, deductible
		0,25	Unevolved forms of the relief
	<b>Diversity of elements of interest (Vst1c)</b>	1	More than five elements of interest (geomorphologic, etc.)
		0,75	3-4 elements of interest
		0,5	2 elements of interest
		0,25	One element of interest
		0	No elements of interest
	<b>Integrity (degree of conservation) (Vst1d)</b>	1	Unaffected geomorphosite
		0,75	Little affected geomorphosite
		0,5	Affected geomorphosite
		0,25	Heavily affected geomorphosite
		0	Destroyed geomorphosite
	<b>Rarity (Vst1e)</b>	1	Internationally unique geomorphosite
0,75		Nationally unique geomorphosite	
0,5		Regionally unique geomorphosite	
0,25		Areal unique geomorphosite	
0		Common geomorphosite	
<b>VALOARE ESTETICĂ (Vst2)</b>	<b>Appearance (Vst2a)</b>	1	Geomorphosite with a unique physiognomy
		0,75	Geomorphosite with a remarkable physiognomy
		0,5	Geomorphosite with an interesting physiognomy
		0,25	Geomorphosite with a common physiognomy
		0	Geomorphosite without attractive attributes
	<b>Chromatics (Vst2b)</b>	1	Chromatic contrast
		0,75	Chromatic puzzle
		0,5	Chromatic blending
		0,25	Monochromic
	<b>Vertical development (Vst2c)</b>	1	Over 500m
		0,75	150-500m
		0,5	50-150m
		0,25	5-50m
		0	Under 5m
	<b>Landscape attractiveness</b>	1	Geomorphosite protected for landscape content
0,75		The landscape is an essential component of the general panorama	

	<b>(Vst2d)</b>	0,5	Attractive landscape on a regional level
		0,25	Attractive landscape on a local level
		0	Unattractive landscape
	<b>Visibility (Vst2e)</b>	1	Geomorphosite perceived panoramically
		0,75	Geomorphosite perceived from an overlook
		0,5	Geomorphosite perceived selectively
		0,25	Geomorphosite perceived punctually
	0	Geomorphosite perceived restrictively	
<b>VALOARE ECOLOGICĂ (Vst3)</b>	<b>Flora (Vst3a)</b>	1	Glacial relic plants
		0,75	Protected plants from the Red List of the superior plants in Romania
		0,5	Natural forestry vegetation
		0,25	Common vegetation
	<b>Fauna (Vst3b)</b>	1	Unique fauna biotope in a regional level
		0,75	Rare fauna biotope
		0,5	Representative fauna biotope to the area
		0,25	Common fauna biotope
		0	Unrepresentative biotope
	<b>Protection (Vst3c)</b>	1	Completely protected area
		0,75	Geomorphosite with vaguely general protection
		0,5	Geomorphosite with selective protection
		0,25	Geomorphosite with limited, natural protection
		0	Unprotected geomorphosite

Calculating the structural value we use:

$$\mathbf{Vst = Vst1 + Vst2 + Vst3}$$

Where:

**Vst** – Structural value

**Vst1** – Geomorphologic value

**Vst2** – Esthetic value

**Vst3** – Ecologic value

The mentioned values were calculated by adding their own criteria, just like in the following example:

$$\mathbf{Vst1 = Vst1a + Vst1b + Vst1c + Vst1d + Vst1e}$$

In the third section of the chart the additional or structural values are evaluated, which derive from the functional values and represent those values attributed by people like scientific value, cultural value and touristic value. Just like in the previous phase, to the additional values we adjoin five quantitative indicators with values from 0 to 1 for a numeric evaluation. The values are presented in Table nr. 2 pages 26-28.

**Tablenr.2. QUANTITATIVE INDICATORS IN EVALUATING GEOMORPHOSITES**

<b>SCIENTIFIC VALUE (Vfn1)</b>	<b>Presence Of scientific activity (Vfn1a)</b>	1	With international representativeness
		0,75	With national representativeness
		0,5	With regional representativeness
		0,25	With local representativeness
		0	Unrepresentative geomorphosite
	<b>Degree of scientific knowledge (Vfn1b)</b>	1	Appearing in several scientific article in international journals
		0,75	Appearing in at least one scientific article in international journals
		0,5	Appearing in at least one scientific article in national journals
		0,25	Some references in national journals or in articles in regional journals
		0	With no scientific reference
	<b>Representativeness of geomorphologic processes and pedagogic interest (Vfn1c)</b>	1	A good example of processes and a good pedagogic resource
		0,75	A good example of processes but with a moderate pedagogic interest
		0,5	Some processes and a low pedagogic level
		0,25	Poor representativeness of processes and without pedagogic interest
	<b>Paleogeographic interest (Vfn1d)</b>	1	Geomorphosite of great paleogeographic interest
		0,75	Geomorphosite of big paleogeographic interest
		0,5	Geomorphosite of moderate paleogeographic interest
		0,25	Geomorphosite of lower paleogeographic interest
		0	Geomorphosite of no paleogeographic interest
	<b>Formative resources (Vfn1e)</b>	1	With multilevel addressability
0,75		With major addressability the domain of interest	
0,5		With average addressability	
0,25		With reduced addressability	
0		Without formative values	
<b>CULTURAL VALUE (Vfn2)</b>	<b>Historical (Vfn2a)</b>	1	Defining archeological sites in a national context
		0,75	Defining archeological sites for the region
		0,5	Defining archeological sites in a local context
		0,25	Archeological sites without special relevance
		0	Lack of archeological sites
	<b>Archeological (Vfn2b)</b>	1	Prehistoric sites
		0,75	Ancient sites
		0,5	Medieval sites
		0,25	Sites with minor relevance
		0	Lack of archeological sites
	<b>Religious (Vfn2c)</b>	1	Monasteries
		0,75	Cathedrals
		0,5	Churches and chapels
		0,25	Recent religious buildings
		0	Lack of religious buildings
	<b>Artistic (Vfn2d)</b>	1	In more than 50 representations in works of art (literature, picture, photo)
		0,75	Between 30 and 50 representations
		0,5	Between 10 and 30 representations

	<b>Associated manifestations (Vfn2e)</b>	0,25	Under 10 representations	
		0	No representations	
		1	One large and significant event	
		0,75	At least three annual events	
		0,5	One annual significant event and other occasional events	
		0,25	Occasional events	
	<b>Architectural (Vfn2f)</b>	0	No events	
		1	Unknown rural site	
		0,75	Traditional architecture	
		0,5	Modern architecture	
		0,25	Common architecture	
	<b>TOURISTIC VALUE (Vfn3)</b>	<b>Number of possible activities (Vfn3a)</b>	0	Lack of architectural value
			1	Over 5 activities (scientific, recreational, touristic, etc.)
			0,75	4-5 activities
0,5			2-3 activities	
0,25			One activity	
<b>Accessibilities (Vfn3b)</b>		0	No activity	
		1	Direct access by vehicles from the main road	
		0,75	Direct access from secondary streets	
		0,5	Direct access for vehicles through non asphalted roads	
		0,25	Vehicle access until 500 meters of the site	
<b>Relations with polarizing centers (Vfn3c)</b>		0	Vehicle access until 1-3 km of the site	
		1	Distance under 5 km from modern centers and with complete services	
		0,75	Distance under 10 km	
		0,5	Distance under 25 km	
		0,25	Distance under 50 km	
<b>Economic and social characteristics of the peripheral regions(Vfn3d)</b>		0	Distance over 50 km	
		1	Areas and urban centers with population exceeding 100,000 located less than 50 km	
		0,75	Areas and urban centers with population exceeding 50,000 located less than 50 km	
		0,5	Areas and urban centers with population exceeding 25,000 located less than 50 km	
		0,25	Areas and urban centers with population exceeding 10,000 located less than 50 km	
<b>Touristic marketing potential (Vfn3e)</b>		0	Areas and urban centers with population under 10,000 located less than 50 km	
		1	Tourism objective of international interest	
		0,75	Tourism objective of national interest	
		0,5	Tourism objective of regional interest	
		0,25	Tourism objective of local interest	
<b>Complementary tourism infrastructure (Vfn3f)</b>		0	Tourism objective generating no interest	
		1	Accommodation in hotels, chalets, pensions close to the tourism objective	
		0,75	Accommodation in villas, camping sites close to the tourism objective	
	0,5	Accommodation in agro-touristic pensions less than 2 km from the objective		
	0,25	Accommodation located between 2 and 10 km from the objective		
<b>Level of amenities with tourism services (Vfn3g)</b>	0	Accommodation located further than 10 km from the objective		
	1	Amenities and modern services within the geomorphosites perimeter		
	0,75	Amenities and modern services on the peripheries of the geomorphosite		
	0,5	Amenities and modern services located less than 15 km from the geomorphosite		
	0,25	Scarce amenities and services		
		0	Lack of amenities and services	

<b>Level of present tourism exploitation (Vfn3h)</b>	1	Permanent touristic exploitation
	0,75	Seasonal touristic exploitation, through 3 seasons
	0,5	Seasonal touristic exploitation, through 2 seasons
	0,25	Seasonal touristic exploitation, through 1 season
	0	Occasional touristic exploitation
<b>Daily tourism exploitation (hours) (Vfn3f)</b>	1	Touristic exploitation over more than 9 hours a day
	0,75	Touristic exploitation between 6 and 9 hours a day
	0,5	Touristic exploitation between 3 and 6 hours a day
	0,25	Touristic exploitation less than 3 hours a day
	0	Touristic exploitation under one hour a day
<b>Tourism promotion of geomorphosites (Vfn3f)</b>	1	Tourism promoting at international level
	0,75	Tourism promoting at national level
	0,5	Tourism promoting at regional level
	0,25	Tourism promoting at local level
	0	Without promoting

For a **scientific evaluation** there were used criteria to reflect *the importance of the geomorphosites from an educational point of view* and without overlaying these with the criteria used for the geomorphologic evaluation. For the economic and touristic evaluation the criteria were selected according to their importance for the tourism development.

The formula used to calculate the **functional value**:

$$Vfn = Vfn1 + Vfn2 + Vfn3$$

**Vfn** – Functional or additional value

**Vfn1** – Scientific value

**Vfn2** – Cultural value

**Vfn3** – Touristic value

**The Functional values**, just like in the previous phase, are calculated by adding the criteria which stood at the base of their evaluation and quantification.

In the last section of the chart are enumerated some restrictive and negative criteria with affect the tourism potential and the esthetic value of the geomorphosites. The **restrictive value** will result from the sum of these criteria mentioned in Table nr. 3.

$$Vr = Vr1 + Vr2 + Vr3$$

**Vr** = restrictive value

**Vr1** = vulnerability to natural processes

**Vr2** = anthropic activities

Vr3 = unaesthetic elements

**Table. nr.3. EVALUATION INDICATORS FOR THE RESTRICTIVE VALUES**

<b>RESTRICTIVE VALUE (Vr)</b>	<b>Vulnerability to natural processes (Vr1)</b>	0	The site is not vulnerable
		0,25	The site is partially vulnerable
		0,5	The site is vulnerable in about 50%
		0,75	The site is totally vulnerable
		1	The site is destroyed
	<b>Anthropic activities (Vr2)</b>	0	Lack of some destructive activities
		0,25	Intense touristic exploitation
		0,5	Irrational agricultural or touristic exploitation
		0,75	Forestry exploitation
		1	Nonindustrial or industrial exploitation
	<b>Unaesthetic elements (Vr3)</b>	0	Lack of unaesthetic elements
		0,25	Miner unaesthetic elements (Graffiti, carvings, abandoned)
		0,5	Household waste
		0,75	Industrial residues
		1	Abandoned industrial infrastructures

For calculating the **total value (VT)** of the geomorphosites we need to add up the structural value (Vst) and the functional value (Vfn) and from their combined value we subtract the restrictive value (Vr):

$$VT = Vst + Vfn - Vr$$

The above presented chart is used in the evaluation of the geomorphosites from the Harghita Mountains. With this the geomorphosites are quantitatively evaluated, resulting in a final grade based on which they are put in a hierarchy. Due to this grade for each value it is possible a classification of the geomorphosites according to the highest value of the site.

### **GEOMORPHOSITE RESEARCH ON A GLOBAL SCALE**

Concept developed exclusively by the Italian, Swiss and Portuguese geologic and geomorphologic schools. Thus we have in:

- In 1993 is introduced the notion of: Geomorphological assets/ Biens géomorphologiques by M. Panizza;
- In 1994 appears a new notion defined by Carton, A. and collab. – “Geomorphological goods/ Biens géomorphologiques;

- In 1994 Hooke defines the notion of Geomorphosites/ Sites géomorphologiques);
- 1995, 1997, 1999 Grandgirard and collab., introduce the notion of Geomorphological geotopes/ Géotopes géomorphologiques;
- 1997, Rivas and collab., define the notion Sites of geomorphological interest/Sites d' intérêt géomorphologique;
- 2001, Panizza, M. adopts a new term: Geomorphosite/ Géomorphosite;
- 2004, 2005, 2009, Reynard, E., redefines the term geomorphosite taken from Panizza;
- 2007, Pralong, J., redefines the term geomorphosite and explains the methods to research and putting them to use.

#### **BRIEF HISTORY IN RESEARCHING GEOMORPHOSITES IN ROMANIA**

The first articles written on this thematic belong to the *geographers from Oradea*: Nicolae Josan and Dorina Ilieș:

- *Preliminary contribution to the investigation of the geosites from Apuseni Mountains (Romania)* - Dorina Ilieș, Nicolae Josan (2007);
- *Some aspects regarding the genesis of geosites* - Dorina Ilieș, Nicolae Josan (2008);
- *Geosites- Geomorphosites and Relief* - Dorina Ilieș, Nicolae Josan (2009);

*The geographers from Bucharest* take part in the development of this subject in their articles:

- *Inventing, Evaluating and Tourism Valuating the Geomorphosites from the Central Sector of the Cehlău Național Park* – Laura Comănescu, Dobre, R. (2008);
- *Inventing and Evaluation of Geomorphosites în the Bucegi Mountains* – Laura Comănescu, Nedelea, N., Dobre, R. (2009);
- *Geotope, Geosite, Geomorphosite* - Ielenicz. M. (2009).
- *Relieful – resursă de bază a turismului. Geomorfodiversitate și geomorfosituri.* Fundației România de Măine Printing House, București ( Posea, Gr., 2012),

*Geographers from Cluj-Napoca* especially the geomorphologists, who developed this thematic were:

- Mac, I., who defines the term site in 2000;
- Petrea, D., in 2005 defines the term site as: “being an area of significant importance”;
- Surdeanu, V., and collaborators initiate in 2009 an inventorying project for the geomorphosites with landslides in Transylvania;
- *Inventoring Cards for Regionally Relevant geomorfosites* – Gabriela Cocean (2011);
- *The Assessment of Geomorphosites of Touristic Interest în The Trascău Mountains* - Gabriela Cocean, Surdeanu, V. (2011);
- *Munții Trascăului – Relief, Geomorfosituri, Turism* – Gabriela Cocean (2011);
- Irimuş, I.A. (2010), describes the relief from the point of view of its potential and possible marketing, then later dedicates large spaces for studying geomorphosites within Transylvania along the PhD candidates. The studies target the reevaluation of the investigation criteria of the geomorphosites together with their tourism marketing possibilities. We will enumerate just a couple of the more representative articles written in teams by the geomorphologists from the Babes-Bolyai University in journals and publications graded ISI and ISI Conference Proceedings between 2012 and 2017:
- *Geomorfositurile pe sare din Depresiunea Transilvaniei și valorificarea lor turistică* – Bianca Toma (2012)
- *Valorificarea turistică a geomorfositurilor din Subcarpații Buzăului* – Irimia, D.N (2013).
- *Criterii de clasificare și evaluare a geomorfositurilor vulcanice din Munții Harghitei* – Irimuş, I.A. & Balint-Balint L. et al (2015).
- *Tourism valorification on Karst geomorphosystems in Surduc-Munticelu* (Crisan, H.F, Irimuş, I.A., Peteley, A., Balint-Balint, L., Cioban, T.D., Dombay, St. (2016).



- *Geomorphosites in Haghimaş Mountains* (Crişan, H-F., Irimuş, Ioan-Aurel, Hirlav, C., Peteley, A., Nita, A.(2015);
- *Karst Geomorphosites from Giurgeu Mountains (Romania)*, Crişan, H-F, Irimuş, Ioan-Aurel, Peteley, A., Balint -Balint, L, Mara, V.(2015).

## EVALUATING VOLCANIC GEOMORPHOSITES IN THE HARGHITA MOUNTAINS

The morphologic evolution of volcanic cones and plateaus, of volcanic craters and valleys, the manifestation of mofettas and mineral springs allowed us (based on the geomorphologic criteria) the separation of three types of geomorphosites in the Harghita Mountains: *volcanic geomorphosites*, *hydrogeomorphosites* and *geomorphohydrosites*. The geomorphosites resulted from lava eruptions and their consolidation, either in volcanic cones (volcanic ash cones, layered lava cones and pyroclastic materials) or in lava plateaus, plateaus of volcanic agglomerates, necks, dykes, sills, craters, calderas, etc., were assimilated by the *volcanic geomorphosite* subtype. *Volcanic geomorphohydrosites* include the barancos type valleys, with defiles, thresholds, cascades, and volcanic crater lakes (Saint Ana Lake), and the *volcanic hydrogeomorphosites* consists those areas whose genesis is linked to the post-volcanic activities respectively the mofettas and mineral springs (Irimuş, I.A. & Balint-Balint L. et al. 2015).

The evaluation of the volcanic geomorphosites according to their scientific value (**Vsci**), landscape and esthetic value (**Vsce**), cultural and historic value (**Vcult**), ecologic value (**Vecol**), social economic value (**Veco**), was done based on the Pralong method (2005), being adapted to the Neocenevolcanic relief of the Harghita Mountains and completed by a series of regional evaluation criteria (geomorphologic units, subunits, forms of the relief, oronyms, toponims, hydromins), showing the specificity of the Carpathian Volcanism of the Pliocene-Quaternary periods (Irimuş, I.A. & Balint-Balint L. et al. 2015). Analyzing the inventoried volcanic geomorphosites led us to create three genetic subtypes (volcanic geomorphosites, volcanic geomorphohydrositees and volcanic hydrogeomorphosites), differentiated according to the geomorphologic criteria (Irimuş, I.A. & Balint-Balint L 2015).

The *touristic value* (*Vtour*) of the volcanic geomorphosites is the resulting sum of the scientific value, esthetic (landscape) value, educational value (cultural-historic), ecologic value and social-economic value. The total tourism value of a geomorphosite cannot exceed

30 points. This is accomplishable by giving grades between 0 and 1 for every one structural or functional point of reference of the volcanic landscape which provides its expressiveness, representation, integrity, utility and sustainability (Irimuş, I.A. & Balint-Balint L. 2015).

The *scientific value (Vsci)* was appreciated through: the paleogeographic interest of the geomorphosite (0-1); representativeness (uniqueness) among the geomorphosites of the same subtype (0-1); the aptitude of the processes (surface, altitude, intensity) (0-1); the vulnerability of the geomorphosite to natural and anthropic processes (0-1); the utility of the geomorphosite (resource exploitation, conservation, protection) (0-1) (Irimuş, I.A. & Balint-Balint L. et al. 2015).

*Landscape and esthetic value (Vsce)* was realized according to: number of overlook points (0-1); variety in the scenery (complexity, simplicity) (0-1); the chromatic contrast of the landscape (0-1); the overlooks altitude (0-1); the accessibility of the observation points (0-1) (Irimuş, I.A. & Balint-Balint L. et al. 2015).

*Educational or cultural-historic value (Vcult)* is the result of: the representation of the geomorphosites in arts (sculpture, paintings, images, photos) (0-1); the representativeness of the sites for archeology (signs of existence of died out plants, animals, or human settlements) (0-1); its religious relevance (0-1); its relevance in local customs and habits (0-1); its relevance in conserving some forms of traditional rural economy (0-1) (Irimuş, I.A. & Balint-Balint L. et al. 2015).

*Ecologic value (Vecol)* is the result of: number of flora species (0-1); number of fauna species (0-1); number of rare species (0-1); endemic species (0-1); the state of the geomorphosite (reservation, natural park, state park) (0-1) (Irimuş, I.A. & Balint-Balint L. et al. 2015).

*Social-economic value (Vsco)*, is the result of: the type of exploitation of the geomorphosite (0-1); the accessibility of the geomorphosite (0-1); natural risks (0-1); annual number of visitors (0-1); the official level of protection (0-1) (Irimuş, I.A. & Balint-Balint L. et al. 2015).

*The touristic value (Vtour)* of the geomorphosites was calculated by adding up the partial values of the scientific value, esthetic and landscape value, educational or cultural-historic value, ecologic and social-economic value according to the Pralong formula, 2005, adapted to the inventoried, classified and evaluated geomorphosites in the Harghita Mountains (Irimuş, I.A. & Balint-Balint L. et al. 2015):

$$V_{tour} = V_{sci} + V_{sce} + V_{cult} + V_{ecol} + V_{eco}$$

The *scientific value* of these geomorphosites resides in the contained information of the eruptive Neogene cycles within the Eastern Carpathians in order to explain the Neogene volcanism and magmatism in the Carpathian-Pannonic region, and the *cultural and historic value* resides in the place of pilgrimage from Sumuleu Ciuc for the local Catholic Szekler communities (Sumuleu Volcano, a representative volcanic landmark with 1033 meters altitude (Irimuş, I.A. & Balint-Balint L. et al. 2015).

The *esthetic value* which is the result of human perception of the landscape and scenery, and is subjectively attributed regarding our level of competence and forming as specialists within a certain area of geomorphology (engineering geomorphology, dynamic geomorphology, climatic geomorphology) or geology (volcanology, structural geomorphology) ((Irimuş, I.A. & Balint-Balint L. et al. 2015).

These unique geomorphologic landscapes or a scenery which is very complex structurally and functionally, can be modified, deteriorated or even destroyed through the impact of human activities (mining activities, forestry exploitation activities, mineral water exploitation, touristic activities).

Their vulnerability to human activities imposes exploitation restrictions even through tourism activities and a rigorous management could assure its protection and conservation (*educational or pedagogic value*), because not all forms of the relief are geomorphosites (Irimuş, I.A. & Balint-Balint L. et al. 2015).

The *social-economic value* of the geomorphosites from the Harghita Mountains was deduced from the impact of the forms of exploitation of the landscape resources through the cartography of the land, structuring a scientific database and elaborating geo-touristic maps with the aim to better manage the existing geomorphologic heritage (Irimuş, I.A. & Balint-Balint L. et al. 2015).

From the 58 inventoried geomorphosites (see Table Nr.4), not all are found within the administrative unit of the Harghita Mountains, but have been introduced in this list of volcanic geomorphosites because they are a result of the volcanic and magmatic processes within the Harghita Mountains, or they can be found on the limits of the neighboring units, on volcanic plateaus or on foothills (Irimuş, I.A. & Balint-Balint L. et al. 2015).

## **TIPOLOGY OF VOLCANIC GEOMORPHOSITES**

TIPOLOGIA GEOMORFOSITURILOR DIN MUNTII HARGHITA																		
Nr.	Denumirea GEOMORFOSIT-ului	CRITERIUL GEOLOGIC		CRITERIUL GEOMORFOLOGIC			CRITERIUL FUNCTIONAL				CRITERIUL STRUCTURAL			CRITERIUL TURISTIC				
		CRATER	PLATOU VULCANIC	VERSANT	GLACIS	DEFILEU	ELEMENT DE PEISAJ	REZERVATIEF LORISTICA	REZERVATIE GEOLOGICA	REZERVATIE FAUNISTICA	GEOMORFOSIT VULCANIC	GEOMORFOIDRUSI VULCANICI	HIROGEO-MORFOSITI VULCANICI	TURISM DE RECREERE	TURISM BALNEAR	TURISM DE AGREMENT	TURISM STIINTIFIC	TURISM CULTURAL
1	Băile Balványos			X							X			X	X	X		X
a.	Peșterea Puturosu			X							X			X	X		X	
b.	Cimitirul Păsărilor			X							X							
c.	Peșterea Timos			X							X			X	X		X	
2	Lacul Sfânta Ana	X					X					X		X		X	X	X
3	Tinovul Mohos	X					X	X		X		X		X		X	X	X
4	Valea Puturosu				X							X						
5	Baia Nyír - Lázárești				X							X		X				
6	Baia Nadas				X				X					X		X		X
7	Defileul Băile Tușnad					X	X					X		X	X	X		
a.	Piatra Șoimilor				X	X	X	X			X			X	X	X	X	X
b.	Sâncile Turmuri				X	X					X			X		X		X
c.	Lacul Ciucaș				X	X						X			X			
d.	Mofeta				X							X		X	X			
e.	Baia termală				X							X		X	X			
8	Tinovul Valea de Mijloc				X			X		X						X		X
9	Tinovul Nyirkert				X			X		X						X		X
10	Tinovul Varsavesz				X			X		X						X		X
11	Tinovul Benes				X			X		X						X		X
12	Tinovul Eges				X			X		X						X		X
13	Tinovul Csemo				X			X		X						X		X
14	Tinovul Honcsok				X			X		X						X		X
15	Tinovul Borsaros Inferior				X			X		X						X		X
16	Tinovul Borsaros Superior				X			X		X						X		X
17	Baia Borsaros				X					X		X		X				X
18	Craterul Cucu	X								X			X					X
19	Valea Stivelor/Minei			X						X								
20	Rez. Geologică Săncraieni			X					X	X						X		X
21	Băile/Tinovul Pucioasa			X						X			X	X	X	X		X
22	Tinovul Luci	X					X	X				X	X	X		X		X
23	Băile Zsigodin				X						X		X	X				X
a.	Defileul Otlului				X	X					X							
b.	Csibanyos				X	X	X					X				X		X
24	Dyke Zsigodin - Șumuleu				X	X				X							X	
25	Baia Călugărilor Șumuleu				X							X		X				
26	Băile M. Ciuc				X							X		X				
27	Băile Harghita			X								X	X	X	X			X
28	Harghita Madaras			X			X			X			X	X	X			X
29	Lacul Dracului	X					X	X			X		X			X		X
30	Baia Bogat				X							X		X				
31	Baia Dugas				X							X		X				
32	Baia Madicsa			X								X		X				
33	Baia Sfânta Ana				X							X		X				
34	Cheile Sârtii -Prajd					X	X			X			X			X		X
35	Conuri aragonit -Corund			X			X			X			X					X
36	Baia Szejke		X					X				X		X				
37	Băile Homorod		X									X		X	X			X
38	Baia termală -Vlahița		X									X		X	X			
39	Poiana Narciselor		X				X	X		X			X	X	X	X		X
40	Kalibasko/Piatra Bufnitei			X			X			X			X		X			
41	Băile Cirui			X										X				
42	Băile Nadasszekei			X								X		X				
43	Băile Szeltersz				X							X		X				
44	Cheile Varghisului				X	X		X	X	X			X		X	X		X
45	Conuri de bazalt -Racoș				X	X				X			X					X
46	Defileul Olt - Racoș				X	X					X		X					
47	Baia Bațani Mici		X									X		X				
48	Furnarul Bodvaj			X			X		X	X			X				X	X
49	Con Vulcanic Murgu			X			X			X			X					X
50	Izvoarele Malnaș Băi					X						X		X	X			
51	Cariera Bixad				X	X				X				X	X			
52	Baia Mikeș				X							X		X				
53	Piatra Șomko				X	X				X			X		X			X
54	T. Dumbrava Harghitei		X				X	X		X		X				X		X
55	Con Vulc. Haromul Mare			X						X			X					X
56	Con Vulc. Haromul Mic			X						X			X					X
57	Lacul Baraj Zetea				X	X						X		X	X			X
58	Neck - Racu				X	X				X			X					

Table Nr.4. Typology of volcanic geomorphosites from the Harghita Mountains.

## RESULTS AND DISCUSSIONS

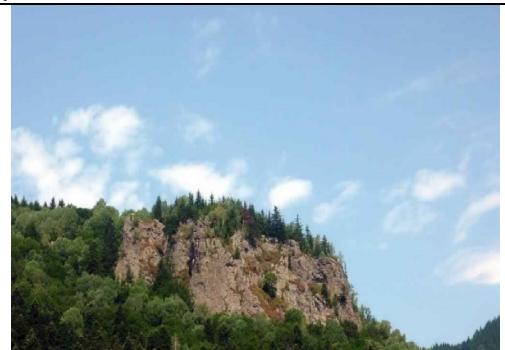
### VOLCANIC GEOMORPHOSITES

The *volcanic geomorphosites* are those sites whose genesis took place in the effusive or post-volcanic cycles. The exogenous modeling didn't erase the primary characteristics of the geomorphosite. The inventoried geomorphosites are: the Cucu crater, Jigodin – Şumuleu dyke, the aragonite cone from Corund, the cones and basaltic pillars from Racoş, volcanic cone from Murgu, Piatra Şomko neck, Haromul Mare and Haromul Mic volcanic cones, the Racu neck, Piatra Şoimilor neck, Stâncile Turnuri (The Tower Cliffs) (Băile Tuşnad), the Geological Reservation from Sâncrăieni, Băile Balványos Baths (Peşterea Puturoasă Cave, Peşterea Timsos Cave, Cimitirul Păsărilor Cave), Valea Stivelor / Minei Valley, the Olt River's Defile from Jigodin, Harghita-Mădăraş, The Salt Straights from Praid, Poiana Narciselor (Narcissus Meadow), Piatra Bufniţei (Owl's Rock), Cheile Vărghişului Gorges, Furnalul de la Bodvaj Furnace, Rock Mines from Bixad şi Malnaş.

Dintre *geomorfositurile vulcanice* identificate au fost alese cele mai reprezentative, dyke-ul Jigodin - Şumuleu, conurile vulcanice Haromul Mare şi Haromul Mic, neck-ul Piatra Şoimilor, neck-ul Piatra Şomko, iar pentru ilustrarea modului de analiză a fost întocmită fişa geomorfositului.

From the identified *volcanic geomorphosites* the most representative ones were chosen: the Jigodin – Şumuleu dyke, the volcanic cones from Haromul mare and Haromul Mic, Piatra Şoimilor neck, Piatra Şomko neck, and to illustrate the method used for analysis the evaluation chart of the geomorphosite was created.

Name	Piatra Şoimilor	
Indicative	<b>G3</b>	
Location	On the eastern slope of the volcanic cone Pilişca and west of Băile Tuşnad Spa Resort	
UAT	Băile Tuşnad, Harghita County	
Typology	Volcanic Geomorphosite	
<b>Total Value</b>	<b>21,50</b>	
Structural Value	10,50	
Functional Value	12,50	
Restrictive value	1,50	




STRUCTURAL VALUE		
TYPE	PCT	Justification
Geomorphologic	3,75	<ul style="list-style-type: none"> <li>* Genesis with the implication of at least three morphogenetic factors: of tectonic nature, volcanic and geomorphologic (0,75 p)</li> <li>* Forms of the relief with accelerated dynamics (1 p)</li> <li>* Presents four elements of interest: geomorphologic, volcanic, lithological and biological (0,75 p)</li> <li>* Geomorphosite little affected by geomorphologic processes (0,75 p)</li> <li>* Regionally unique geomorphosite (0,5 p)</li> </ul>
Esthetic	4,50	<ul style="list-style-type: none"> <li>* geomorphosite with unique physiognomy (1 p)</li> <li>* Chromatic contrast (1 p)</li> <li>* Vertical development on 244 meters in reference to the Olt River and the Ciucaș Lake (the slopes of the rocks have 60 meters in altitude (0,75p)</li> <li>* The scenery is an essential component of the general panorama (0,75 p)</li> <li>* Panoramicly perceived geomorphosite (1 p)</li> </ul>
Ecologic	2,25	<ul style="list-style-type: none"> <li>* Plants protected on the Red List of Superior Plants in Romania (0,75 p)</li> <li>* Fauna representative for the are (0,5 p)</li> <li>* Completely protected area (1 p)</li> </ul>
FUNCTIONAL VALUE		
TYPE	PCT	Justification
Scientific	5,00	<ul style="list-style-type: none"> <li>* International scientific representativeness (1 p)</li> <li>* Appeared in multiple scientific articles published in international journals and in conference proceedings (1 p)</li> <li>* A good example of processes and a good pedagogic resource(1 p)</li> <li>* Geomorphosite of great paleogeographic interest (1 p)</li> <li>* Has polyvalent addressability with geologic, geomorphologic, volcanogenic and biologic interest (1 p)</li> </ul>
Cultural	1,00	<ul style="list-style-type: none"> <li>* Representation in more than 50 works of art (literature, paintings, photos) (1 p)</li> </ul>
Touristic	6,5	<ul style="list-style-type: none"> <li>* 5 possible activities: scientific, ecotourism, recreational, educational, geotourism (0,75p)</li> <li>* Distance less than 5 km from modern centers and with complete services (1 p)</li> <li>* Areas and urban settlements with population exceeding 50,000 located less than 50 km away (0,75 p)</li> <li>* Touristic objectives of national interest (0,75 p)</li> <li>* Accommodation in hotels, villas, pensions in Băile Tușnad Spa Resort(1 p)</li> <li>* Amenities and modern services at the peripheries of the geomorphosite (0,75 p)</li> <li>* Seasonal touristic exploitation, through 3 seasons (0,75 p)</li> <li>* Tourism promoting at national level (0,75 p)</li> </ul>
RESTRICTIVE VALUE		
PCT	Justification	
1,50	<ul style="list-style-type: none"> <li>* Forestry exploitation (0,75 p)</li> <li>* Household waste (0,5 p)</li> <li>* Site is partially vulnerable (0,25 p)</li> </ul>	

## VOLCANIC GEOMORPHOHYDROSITES

The *volcanic geomorphohydrosites* are represented by the lakes and the peat bogs, which got formed in the eruptive, effusive or explosive cycles, in the craters, and later in these craters the water from precipitations gathered leading to the formation of crater lakes or through eutrophism they transformed into peat bogs. In this category were included: Saint Ana Lake, Tinovul Mohoş peat bog, the Olt River's defile from Băile Tusnad Spa Resort, Dracului Lake, Tinovul Luci peat bog, Olt River's defile from Jogodin, Olt River's defile from Racos, Tinovul Dumbrava Harghitei peat bog, Tinovul Borşaroş Inferior peat bog, Tinovul Borşaroş Superior peat bog, Tinovul Honcsok peat bog, Tinovul Csemo peat bog, Tinovul Eges peat bog, Tinovul Beneş peat bog, Tinovul Varsavesz peat bog, Tinovul Nyirkert peat bog and Tinovul Valea de Mijloc peat bog.

From the identified volcanic geomorphohydrosites the most representatives were chosen, Saint Ana Lake and the Tinovul Mohoş peat bog, and to illustrate the method for analysis we elaborated the evaluation chart of these geomorphosites.

Name	Saint Ana Lake	
Indicative	<b>G1</b>	
Location	In the southern sector of the Harghita Mountains, east of the Olt River's defile from Băile Tuşnad Resort in the volcanic crater of the Ciomadu Massif	
UAT	Cozmeni Parish, Lăzăreşti village, Harghita County	
Typology	Volcanic geomorphohydrosite	
<b>Total Value</b>	<b>23,25</b>	
Structural Value	9,25	
Functional Value	15,00	
Restrictive Value	1,00	

STRUCTURAL VALUE		
TYPE	PCT	Justification
<b>Geomorphologic</b>	4,00	<ul style="list-style-type: none"> <li>* Complex genesis with the implication of multiple morphogenetic factors: of tectonic, volcanic, lithologic, geomorphologic and hydrologic nature (1 p)</li> <li>* Forms of the relief with moderate but perceptible dynamics (0,75 p)</li> <li>* Presents five or more elements of interest : geologic, biologic, geomorphologic, volcanogenic and hydrologic (1 p)</li> <li>* Geomorphosite affected by geomorphologic processes (0,5 p)</li> <li>* Nationally unique geomorphosite (0,75 p)</li> </ul>
<b>Esthetic</b>	3,25	<ul style="list-style-type: none"> <li>* Geomorphosite with unique physiognomy (1 p)</li> <li>* Chromatic agreement between the color of the surrounding vegetation and the lake's water (0,5 p)</li> <li>* The scenery is an essential component of the general panorama (0,75 p)</li> </ul>

		* Panoramically perceived geomorphosite (1 p)
<b>Ecologic</b>	2,00	* Natural forest vegetation (0,5 p) * Fauna representative for the area: wild boar, brown bear, stag, squirrel; and in the lake due to reduced salinity of the water lives only a single species of fish, not yet identified, it is considered to be the bullhead catfish probably introduced by the migrating wild geese (0,5 p) * It is a completely protected area (1 p)
<b>FUNCTIONAL VALUE</b>		
<b>TYPE</b>	<b>PCT</b>	<b>Justification</b>
<b>Scientific</b>	5,00	* International scientific representativeness (1 p) * * Appeared in multiple scientific articles published in international journals and in conference proceedings (1 p) * A good example of processes and a good pedagogic resource (1 p) * Geomorphosite of great paleogeographic interest (1 p) * Has polyvalent addressability with geologic, geomorphologic, geographic, hydrologic and biologic interest (1 p)
<b>Cultural</b>	2,00	* Representation in more than 50 works of art (literature, paintings, photos) (1 p) * On the lake shore there is the Saint Ana Chapel, place for pilgrimage (0,5 p) * One large annual event, the Saint Ana Pilgrimage, and several occasional manifestations during summer season, religious ceremonies, etc. (0,5 p)
<b>Touristic</b>	8,00	* more than 5 possible activities: scientific, cultural, recreational, leisure, ecotourism, religious, sports, educational and geotourism (1 p) * Accessible by vehicles to at least 500 meters from objective (0,25 p) * Distance less than 10 km from modern centers and with complete services (0,75 p) * Areas and urban settlements with population exceeding 50,000 located less than 50 km away (0,75 p) * Touristic objectives of international interest (1 p) * Accommodation further than 10 km from the objective (0,75 p) * Permanent touristic exploitation (1 p) * Touristic exploitation over more than 9 hours a day (1 p) * Touristic promotion on an international level (1 p) * Modern services and amenities less than 15 km from the geomorphosite (0,5 p)
<b>RESTRICTIVE VALUE</b>		
<b>PCT</b>	<b>Justification</b>	
1,00	* The site is partially vulnerable (0,25 p) * Intense tourism exploitation (0,25 p) * Household waste (0,5 p)	

## **VOLCANIC HYDROGEOMORPHOSITES**


*Volcanic hydrogeomorphosites* are represented by thermal mineral water springs, mofetta respectively by post-volcanic processes and activities in which the water as agent (in gas, liquid, mineral or thermal form) coordinates the morphogenesis.

In this category of *hydrogeomorphosites* we included: the thermal spring from Vlăhița, mineral water springs from Lăzărești (64), the spring from Nadaș, the mineral water springs



from Băile Tuşnad (44), Borşaroş Springs, Jigodin Springs, the Monk's Springs and Bath from Şumuleu, Bogat Spring, Szejke Spring, Dugaş Spring, Madicsa Spring, Saint Ana Spring from Tomeşti, the springs from Băile Homorod Resort, Chirui Spring, Nadasszeki Spring, Szeltersz Spring, Băţani Mici Spring, the springs from Malnaş Băi Baths, Mikes Spring, Nyir Bath from Lăzăreşti and the mofetta, the thermal mineral water springs and mofetta from Băile Tuşnad Spa Resort, the springs and mofetta from Băile Pucioasa Baths, The Zetea barrier lake, the Lacul Ciucaş Lake, the mineral water springs and mofetta from Băile Harghita Resort, and the Miercurea-Ciuc Baths.

From the identified *volcanic hydrogeomorphosites* there were chosen the most representative ones: the Nyir (Birch tree) Baths and mofetta from Lăzăreşti and the Monk's Bath from Şumuleu / the volcanic cone from Şumuleu, and to illustrate the method used for analysis we elaborated the evaluation chart of the geomorphosite.

Name	Monk's Bath – Volcanic cone Şumuleu	
Indicative	<b>G4</b>	
Location	At the periphery of Şumuleu-Ciuc settlement, at the foot of the volcanic cone Şumuleu	
UAT	Şumuleu-Ciuc, Harghita County	
Typology	Volcanic Hydrogeomorphosite	
<b>Total Value</b>	<b>20,50</b>	
Structural value	8,25	
Functional value	13,00	
Restrictive value	0,75	

STRUCTURAL VALUE		
Type	PCT	Justification
<b>Geomorphologic</b>	4,00	<ul style="list-style-type: none"> <li>* Genesis with the implication of at least three morphogenetic factors: of tectonic, volcanic, geomorphologic and hydrologic nature (0,75 p)</li> <li>* Forms of the relief with moderate but perceptible dynamics (0,75 p)</li> <li>* Presents many elements of interest: geomorphologic, volcanologic, hydrologic, therapeutic, sports and religious (1 p)</li> <li>* Geomorphosite little affected by geomorphologic processes (0,75 p)</li> <li>* Nationally unique geomorphosite (0,75 p)</li> </ul>
<b>Esthetic</b>	3,25	<ul style="list-style-type: none"> <li>* Geomorphosite with unique physiognomy (1 p)</li> <li>* Chromatic agreement (0,5 p)</li> <li>* The scenery is an essential component of the general panorama (0,75 p)</li> <li>* Panoramicly perceived geomorphosite (1 p)</li> </ul>
<b>Ecologic</b>	1,00	<ul style="list-style-type: none"> <li>* Natural forest vegetation (0,5 p)</li> <li>* Fauna representative for the area (0,5 p)</li> </ul>

FUNCTIONAL VALUE		
Type	PCT	Justification
Scientific	2,75	<ul style="list-style-type: none"> <li>* National scientific representativeness (0,75 p)</li> <li>* Appeared in at least one scientific article published in international (0,75 p)</li> <li>* A good example of processes and a good pedagogic resource (1 p)</li> <li>* Geomorphosite with moderate paleogeographic interest (0,5 p)</li> <li>* Geomorphosite with major addressability in the domains of geology, geomorphology, volcanology and hydrology (0,75 p)</li> </ul>
Cultural	2,00	<ul style="list-style-type: none"> <li>* Saint Anton de Padova's Chapel, Capela Suferinței Lui Isus Hristos Chapel (0,5 p)</li> <li>* Representation in more than 50 works of art (literature, paintings, photos) (1 p)</li> <li>* One large annual event and several occasional manifestations, religious ceremonies, (the Catholic Pilgrimage at Pentecost, The Thousand Szekler Girl's Festival) (0,5 p)</li> </ul>
Touristic	8,25	<ul style="list-style-type: none"> <li>* More than 5 possible activities: scientific, ecotourism, educational tourism, geotourism, sport tourism, religious tourism, bath and curative tourism (1 p)</li> <li>* Direct vehicle access on not asphalted roads (0,5 p)</li> <li>* Distance under 5 km from modern centers and with complete services (1 p)</li> <li>* Areas and urban settlements with population exceeding 50,000 located less than 50 km away (0,75 p)</li> <li>* Touristic objectives of international interest (1 p)</li> <li>* Accommodation in hotels, chalets, pensions close to the tourism objective (1 p)</li> </ul>
		<ul style="list-style-type: none"> <li>* Amenities and modern services located less than 15 km from the geomorphosite (0,5 p)</li> <li>* Permanent touristic exploitation (1 p)</li> <li>* Touristic exploitation between 3 and 6 hours a day (0,5 p)</li> <li>* Tourism promoting at international level (1 p)</li> </ul>
RESTRICTIVE VALUE		
PCT	Justification	
0,75	<ul style="list-style-type: none"> <li>* The Site partially vulnerable (0,25 p)</li> <li>* Household waste (0,5 p)</li> </ul>	

**Table Nr. 5.** *The final scores accomplished by the geomorphosites in the Harghita Mountains*

Nr. crt.	Geomorphosite	Structural Value			Functional Value			Restrictive value	Total Value
		Geomorphologic	Esthetic	Ecologic	Scientific	Cultural	Touristic		
1	<b>Lacul Sfânta Ana Lake</b>	4	3.25	2	5	2	8	1	<b>23.25</b>
2	<b>Tinovul Mohoș Peat Bog</b>	4.25	3	2.75	5	1	6.5	0.25	<b>22.25</b>
3	<b>Piatra Șoimilor Neck - Băile Tușnad</b>	3.75	4.5	2.25	5	1	6.5	1.5	<b>21.5</b>
4	<b>Baia Călugărilor Bath- Volcanic Cone Șumuleu</b>	4	3.25	1	2.75	2	8.25	0.75	<b>20.5</b>
5	<b>"Nyir" (Birch tree) Bath Lăzărești</b>	3.25	2.75	0.5	2.75	1.5	5.25	0.75	<b>15.25</b>
6	<b>Jigodin Dyke - Șumuleu</b>	3.5	2.75	1	3	0.5	5	1.75	<b>14</b>
7	<b>Volcanic cones from Haromul Mare and Haromul Mic</b>	3.75	2.75	1	3.5	0.5	3.5	2	<b>13</b>
8	<b>Piatra Șomko Peak- Bixad</b>	3.25	2.25	1	1.25	1.25	3.75	1.25	<b>11.5</b>

## TOURISTIC GRADING AND MARKETING OF THE GEOMORPHOSITES

The terms tourist and tourism are closely inter-conditioned, the tourist being the motoric element of the whole tourism phenomenon, and after all tourism is all that kind of motoric activity (Cocean, P., 2005). Tourism is a special way of marketing natural resources and the anthropic heritage of an area.

The natural environment and all its components represent one of the two main elements of the touristic heritage of an area (Ciangă, 2001, Bianca Toma, 2012).

Tourism no doubt became of the most dominating phenomena of this contemporary world, becoming one of the most profitable segments of the global economy, being remarkable through its dynamics, multiple motivations and a wide array of forms of manifestation.

George Chabot (1966) appraises that geography and tourism are two terms predestined to be next to each other, because every geographer has to be doubled up by the necessity of being a tourist, and in every tourist there is a hidden or self-ignored geographer.

Tourism as a human activity is unconceivable without the anthropic factor's presence. Thus people become the motoric elements, accomplishing through themselves and for themselves all the composing elements of the tourism phenomena. As a consequence, its place needs to be located, before anything else in the human geography area.

The relief is the main component of the natural environment, thus being the richest and mostly diversified attraction resource on the globe (Cocean, G., 1999, Toma, B., 2012).

The main attractiveness of the relief relies in its landscape value, whose variety differs according to its structure, lithology, tectonics and their impact with all the modeling factors. All forms and shapes of the relief each contribute to the diversification of the attractiveness with a landscape impact, from a general view aspects to micro-relief forms (Ciangă, 2001, Toma, Bianca, 2012).

Muntele. I., and Iațu., C. in their article *Geografia turismului. Concepte, metode și forme de manifestare spațio-temporală*, (Tourism geography, concepts, methods and form of special-temporary manifestation), describe the assumed tourism role of the relief, as an important source of attraction and as a development or inhibitor factor for tourism in a certain area. The relief constitutes a tourism attraction by itself, promoting a wide range of attractions according to the diversity of its specific morphology: peaks, crests, rock faces, rocks, caves, keys, waterfalls, plateaus, depressions, defiles.

Every atlas or brochure signals attraction which use the relief as a pretext even for the perspective it offers over the landscape (overlook points, panorama views) (Bianca Toma, 2012).

After analyzing the structure of the tourism resources we notice that between the elements of the natural environment, the relief has the most significant importance (Cocean, P., 1984), being cataloged as the peak attractive domain. This prime rank is attributed to the diversity of major and minor shapes with distinctive attractive aspects: rock faces, crests, forms of glacial erosion, keys and defiles, caves and horns, volcanic cones and craters, deltas, sinkholes, plateaus. Basically elements which can determine the appearance and development of the tourism phenomena within an area. It is well known, that the base of tourism development within a territory is defined by “the raw materials” is withholds, respectively the objectives that make the geographical unit attractive (G. Cocean, 2011).

Tourism resources from the territory of the Harghita Mountains: the importance of the relief was pointed out by the previously mentioned authors – and it is standing out in its landscape and touristic value within the region, by the value of the volcanic relief (volcanic plateau, foothills, volcanic cones, volcanic craters, defile, necks and dykes), by post volcanic activities (thermal and mineral water springs, mofetta), by the human activity (dug caves of opal, Puturoasa Cave – manmade cave, quarry, Bodvaj furnace, Zetea barrier lake; the pilgrimage places from the Saint Ana Lake – local/religious importance, Șumuleu – international importance, Bogat / Racu – local, Câmpul Capelei / Lăzărești – local) and by the hydro mineral resources (mineral and thermal springs, popular baths, natural and anthropic lakes and bogs).

Until now, exclusively for the territory of the Harghita Mountains no inventory or presentation (tourism brochure) was done regarding the touristic resources (natural and anthropic); the result of this research was the creation of the inventory of the volcanic geomorphosites, outlining its natural and anthropic touristic resources, drawing the attention upon these forms of the relief, which truly deserve to become protected and popularized areas. Also has the purpose of ensuring sufficient information for the elaboration of further marketing strategies, for the promoting of these natural and cultural-historic assets on national and international levels with the direct aim to be included in the regional, national or international tourism circuit.

On the other hand the study reveals the role of tourism resources (natural and anthropic) in the sustainability of a territory which shows a poorly diversified economy, generally being engaged in agriculture and tourism, with a high rate of unemployment and demographic ageing and showing high indicators in emigration of the young generations.

The geomorphosites within the area of the Harghita Mountains are marketed through different forms of tourism, ecotourism, scientific tourism, cultural tourism, religious tourism, spa and therapeutic tourism, leisure tourism, sport tourism, and according to this study now we can consider the educational tourism and geotourism, thus contributing to the social-economic development of this geographic space. Last but not least this study can serve in the creation of a geopark within the Harghita Mountains which will be justifiable through the ecotouristic assets.

**Touristic evaluation and marketing of the inventoried geomorphosites (58)**, proposes the *cartographic representation, their evaluation from a touristic point of view, and a reevaluation of the tourism infrastructure*, especially the road/trail conditions which provide the access to the mentioned objectives. A more serious implication is necessary, and a better financial support from the Local and County Councils, for these geomorphosites to be able to present themselves at their true value. Starting from these conclusions, we will illustrate in the following a couple of tourism marketing models for the geomorphosites in the Harghita Mountains.

### **The volcanic geomorphohydrosite Saint Ana Lake**

Is located at 946 meters altitude, with the geographic coordinates 46.1265204 lat. N, 25.8876047 long. E / Harghita County, Romania, in the administration of Lăzărești parish, being accessible by the roads: **E578 / DN12 – DJ 11C – DJ 113A**.

The Saint Ana Lake (see Photo Nr. 1) owns its renowned name to its location on the bottom of an extinct volcano, a morphologically totally preserved volcanic crater in the Ciomad Massif. This privilege offers a unique landscape and touristic status. It is a *mixt natural reservation*: botanical, geological and scenery-wise, which occupies a total surface of 201.38ha, and is included in the site ROSCIO248 Tinovul Mohoș Peat Bog-Lacul Sfânta Ana Lake. The Saint Ana Lake was proposed for protection initially with the County Council Order nr. 162 from 2005, later being nominated as Natural Reservation through National Law nr. 5

from 2000 regarding the approval of the National Territorial Arrangement Plan – section III, Protected Areas.

The crater of the Saint Ana Lake is the most typical hydrographic basin with endoreic flow from Europe, of volcanic origin and with pluvial and snow supply.

The hydrographic basin is delimited by the volcanic craters crests, with the peaks of Ciomadul Mare, Ciomadul Mic, Tata and Dealul Lacului.

The surface of the lake has 19ha, its perimeter has 1711 meters, the length of the lake measures 620m according to the orthophotoplan from 2005. The first batimetric map was elaborated by Jozsef Gelei in 1909; referring to the depth of the lake there were several studies conducted over time: according to Balazs Orban in 1868 it had 12 meters, in 1955 it had 7 meters, according to Găștescu P., 6,3 m in 1998, according to Pal Zoltan, 6,85 m in 2000, and later 6,5 m in 2012, 5,76 m in 2013, and 6,05 in 2015. These later figures are the result of the measurements done by the teams formed by the Sapientia University and the custodian of the reservation Laszlo Kerezsi within the scientific work *The management plan of the Natural Protected Areas of Saint Ana Lake and Tinovul Mohos Peat Bog*.

On the shoew of the lake it is located the Saint Ana Chapel, which was erected in 1564 by Pal Kecskes, and belongs to the Roman Catholic Parish. The church organizes the Saint Ana pilgrimage, every year on the 26<sup>th</sup> of July, which has become a tradition since the 12<sup>th</sup> century, with thousands of participant. Throughout the year on every Sunday an open air liturgy is held.

Protected animal species: the brown bear *Ursus arctos*, Carpathian stag *Cervus elaphus*, red crossbill *Loxia curvirostra*, the three toed woodpecker *Picoides tridactylus*, the common European viper *Vipera berus*, the sand lizard *Lacerta agilis*, the fire salamander *Salamandra salamandra*, the pintail duck *Anas acuta* and the brown bullhead catfish *Amiurus nebulosus* (Planul de management al ariilor naturale protejate Lacul Sfânta Ana și Tinovul Mohoș = *The management plan of the Natural Protected Areas of Saint Ana Lake and Tinovul Mohos Peat Bog*)

Regardless the fact that there is no official data referring to the total number of annual visitors of the Saint Ana Lake, the estimated number of total visitors exceeds 200,000 yearly, the peak season being in the summer. In the peak days the site can have between 2,000 and 3,000 visitors. A parking fee is perceived for all types of vehicles.

The majority of the visitors bathe in the lake, take a row boating trip on the lake, stroll around the lake, sunbathe, visit the Saint Ana Chapel located on the lakeshore, participate on the Saint Ana Pilgrimage on the 26<sup>th</sup> of July or take part on the religious liturgy held every Sunday or climb to the overlook point to have glimpse of the whole landscape, etc.

In 2017 the fourth edition of the Saint Ana Lake Xterra Triathlon offroad challenge was held, organized by the Extreme Sports Club Băile Tuşnad, which is held in Băile Tuşnad Spa Resort, and on the territories administered by Lăzăreşti and Tuşnadu Nou Parishes and within the Saint Ana Lake - Tinovul Mohoş Peat Bog Natural Reservation with 247 participants. On the 3<sup>rd</sup> edition of the same race in 2016 there were 138 participants eager to answer to the challenge.

Although the peak season is in the summer, we have to mention a significant number of visitors who come to see the Saint Ana Lake in the winter season as well, aside a day's outing in fresh air and admiring the winter scenery, where usually the snow measures more than 1 meter in thickness, many visitors come to slay ride, or go ski touring, or sledge down the 1.7 km long road from the parking area to the lake, and they are brought back by off-road vehicles. The offseason is in spring and in autumn.

The tourism forms practiced are: ecotourism, scientific tourism, religious tourism, leisure tourism, sport tourism and after the completion of this study regarding the geomorphosites we can consider the educational tourism and geotourism as well.

*The legend of the Saint Ana Lake registered by Elek Benedek*

**The legend of St. Ana Lake**, written down by several authors, is a 500 years old tale about human greed and its consequences. It has been told by people throughout the centuries and it still lives on as a tale. It was written down only at the beginning of the 19th century by a well-known Hungarian writer. You should see that lake to feel the mystery.

Once upon a time, in the lush forests of the Transylvanian highlands, there was a beautiful castle which stood near the shore of an old crystal-clear lake born in the crater of an extinguished volcano. In this castle lived a lord who owned almost everything the human heart desires: gold, jewels, hundreds of servants, a pretty wife, and lots of fertile land all around the county. One day he invited his cousin to a party, and his guest arrived in a golden chariot pulled by twelve magnificent pearl-white steeds. They were incredibly graceful, moving with the elegance of seagulls and their eyes shone with pride as they scratched the ground with their



finely polished hooves. As the lord of the castle looked at them, he realized he did want those horses more than anything else in the world.

“I'll buy your horses no matter how much gold they might cost!” he shouted to his cousin. But the answer was ‘No’. He tried again, and became very furious because he saw that the steeds were not for sale.

“Come back tomorrow!” he yelled. “Then I'll show you far more beautiful horses than yours!”

His cousin shook his head but agreed.

When the party was over, the lord started thinking over his promise. “I'm going to show him *my* horses!” he thought.

The next day he sent fifty soldiers to the nearby villages, and ordered them to bring to the castle a dozen virgins, the prettiest dozen they can find. They returned soon, carrying twelve fair maidens, but the fairest of them all was called Ana, and the lord thought “She is going to be the leader!” The girls were dressed up in pearl-white silk, then, suddenly, the guards tied their hands and lead them to a chariot waiting outside. They started to cry as they saw the anguish awaiting for them, but no one seemed to show them any mercy.

A thick leather harness was attached to their silver belts, and they were tied to the chariot!

The lord ordered: “Pull it! Now!”

The girls couldn't move an inch. So he took his whip and hit them hard, shouting “Go, go, you lazy beasts!”

The girls cried as their shoulders started bleeding where the whip touched them. Anna, who was tied before the others, fell to her knees and began to pray.

“Get up!” And the whip struck her back. She didn't seem to notice it... The lake began stirring like a gigantic monster whirlpool, it rose from its bed, and swallowed the castle before the lord struck Anna again. The water fell back, dragging the building with itself into the dark depths of the Earth. It swirled and shined with an eerie blue light, then calmed down slowly.

It turned black again. A dozen snow white swans circled around the lake's center, and below them a huge dragon fought against the suction of the deep, rapaciously stretching out his arms for them, but the swans flew away, disappearing into a nearby bushes. The dragon closed its eyes and went back to sleep in the depths of the lake.

So, the lake gained its name, in honor of the mild but unrelenting maid and this event is remembered every time a human steps into its shining waters.

(Source: [http://cngi.is.edu.ro/travellingineurope/index.php?option=com\\_content&view=article&id=134:the-legend-of-st-ana-lake&catid=53:romania&Itemid=67](http://cngi.is.edu.ro/travellingineurope/index.php?option=com_content&view=article&id=134:the-legend-of-st-ana-lake&catid=53:romania&Itemid=67))

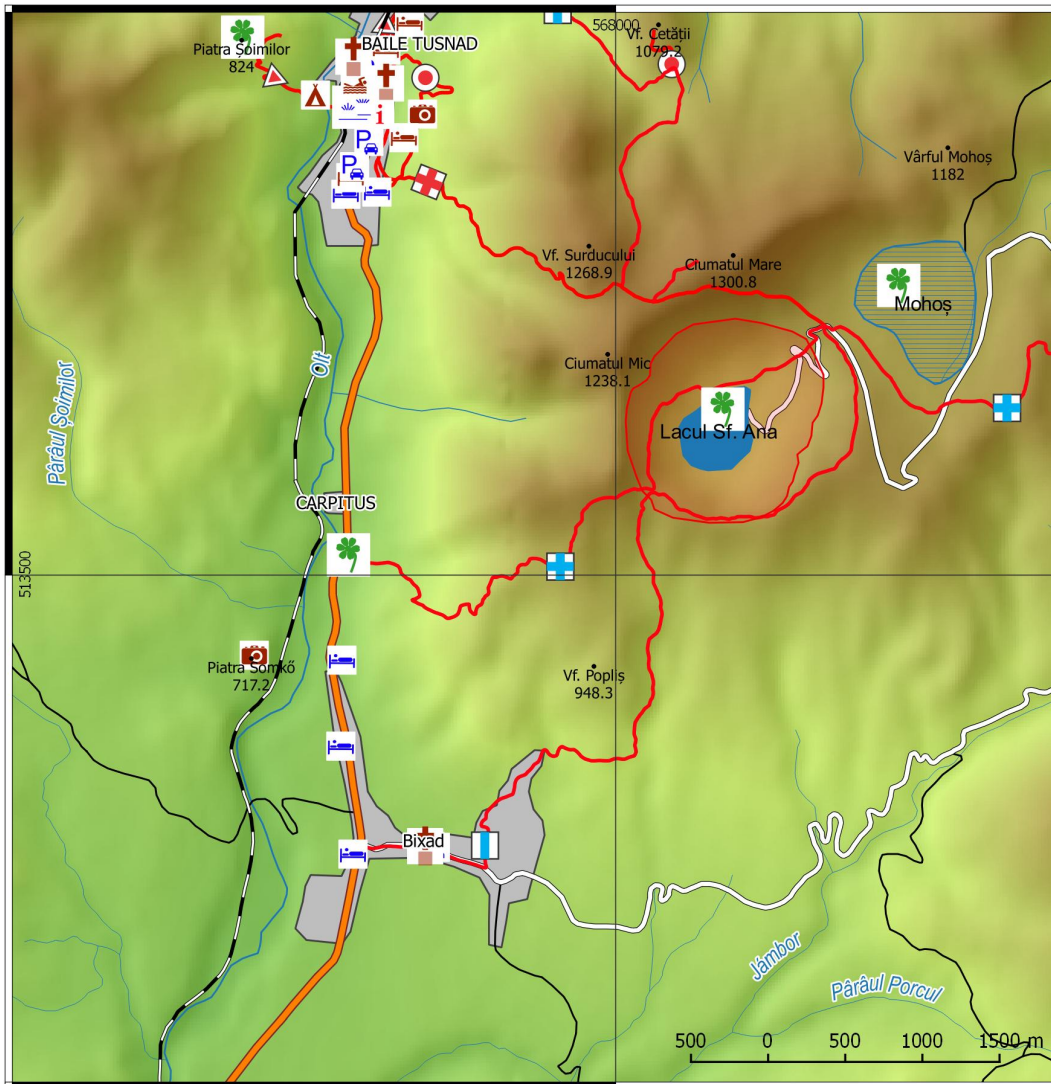


Photo Nr. 1. Saint Ana Lake, Harghita County, Romania

- **Touristic evaluation chart of the volcanic geomorphosite Saint Ana Lake, Harghita Mountains (Photo Nr.1)**

Coordinates 46.1265204 lat N, 25.8876047 long. E / Harghita County, Romania, located at 946 meters altitude; road access: **E578 / DN12 – DJ 11C – DJ 113A.**

<b>Value/reference</b>						<b>TOTAL</b>
<b>VSci</b>	Paleogeographic interest	Representativeness	Amplitude	Vulnerability	Utility	<b>Sum</b>
Points 0-1/reference	1,0	1,0	1,0	1,0	1,0	<b>5,0</b>
<b>Vsce</b>	Overlook points (nr)	Variety of observed scenery	Chromatic contrast	Altitude of observation points	Accessibility of the observation points	
Point 0-1/reference	1,0	1,0	1,0	1,0	1,0	<b>5,0</b>
<b>Vcult</b>	Representativeness for arts	Representativeness for archeology	Representativeness for religion	Relevance for traditions	Relevance for traditional economy	
Point 0-1/reference	1,0	0,1	1,0	1,0	1,0	<b>4,1</b>
<b>Vecol</b>	Flora species	Fauna species	Rare species	Endemic species	Geomorphosite status	
Point 0-1/reference	0,5	0,5	0,1	0,1	1,0	<b>2,2</b>
<b>Veco</b>	Exploitation type	Accessability	Natural risks	Nr. Visitors/year	Official level of protection	
Point 0-1/reference	1,0	1,0	1,0	1,0	1,0	<b>5,0</b>
<b>Touristic value</b>		<b>21,3</b>				



## Geomorfohidrositul Lacul Sf. Ana

harta geoturistică

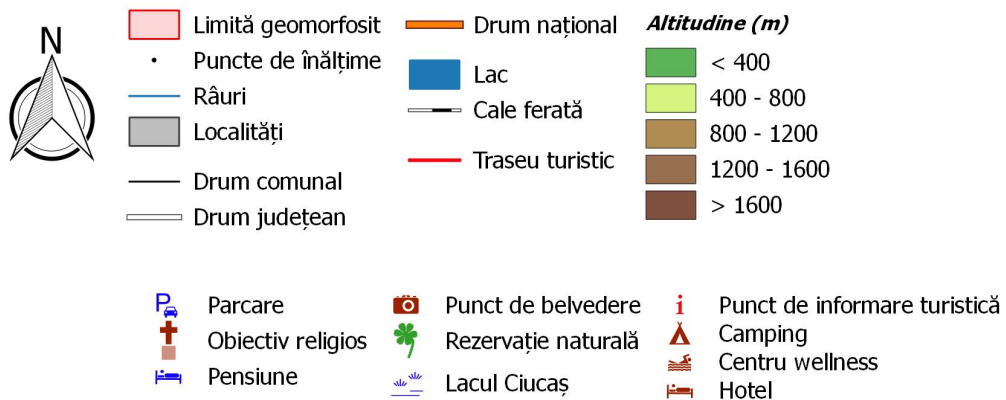


Figure. 1. Saint Ana Lake– Geotouristic map.

## CONCLUSIONS

- The geomorphologic criteria proposed for the evaluation and classification of the forms of the volcanic relief in the Harghita Mountains led to the forming of a typology (geomorphosites, geomorphohydrosites and hydrogeomorphosites) in order to better show their landscape, scientific, ecologic, educational, economic and in the end their touristic value. This unified classification will aid in creating a hierarchy within a volcanic region and in creating the legends for the geotouristic maps of the Romanian volcanic regions within a unitary concept, to better serve the large public who is eager to explore and discover during their excursions.
- The inventorying and evaluation of the geomorphosites from the area of the Harghita Mountains brought to front the richness and variety of its natural and anthropic resources, and the importance of human activities with tourism functions. It is mandatory to conserve these natural values, the elaborate according to sustainable development concepts, with their unified promoting to be included in the touristic circuit on a regional, national and international level. Considering that the area contains a vast touristic potential, a varied volcanic relief (volcanic plateaus, volcanic cones, craters, necks, dykes), numerous mineral and thermal water springs, mofetta and emanations of carbon dioxide and water, numerous natural reservations (geological, landscape, floristic, faunistic), caves, defiles, volcanic crater-lakes, artificial recreational lakes, peat bogs, ski runs, religious artifacts and buildings, historic artifacts, pilgrimage places, sporting events (triathlon, mountain biking, dog slay competitions, off road rallies) these are scarcely marketed.
- The study revealed that in the researched area the best known geomorphosites are ***The Saint Ana Lake and the Tinovul Mohoș Peat Bog***. These show the highest registered scores on our evaluation charts.
- Although the area of the Harghita Mountains presents a rich touristic potential, the most visited areas by tourists is the southern region of the volcanic mountain chain: the *Saint Ana Lake and the Tinovul Mohoș Peat Bog*, respectively the *Șumuleu Ciuc* region. This phenomenon can be explained in the lack of promoting of the resources, the lack of signs and announcement boards towards the tourism objectives, the lack of interest and

involvement from the local and county offices regarding the management and maintenance of the existing resources and accessibility infrastructure, which creates a real impediment in their good use.

- The good marketing of the inventoried resources could have an important role in the sustainability and development of the region, which has a poorly diversified economy and a high rate of unemployment, combined with a demographic aging and high rate of emigration among the young generation. These resources could contribute to the development of the local economy, which will favor the increase of living conditions of the local population by generating new places of work and new forms of income.
- From the final scores presented in Table Nr. 5, which were the results from the evaluation charts done in the studied area, we notice that the most important geomorphosite is the Saint Ana Lake, located in the twin crater of the Tinovului Mohoș Peat Bog, the only volcanic crater lake in Romania, and the only undrained crater from Harghita County's territory. The Saint Ana Lake geomorphosite totaled 23.25 points and is remarked in comparison with the other geomorphosites with its scientific value, landscape and esthetic value, socio-economic value, through its uniqueness, respectively through its educational value, cultural and historic value (due to the pilgrimage organized by the Roman Catholic Church from Lăzărești, every year on the 26<sup>th</sup> of July to the Saint Ana Chapel which is located on the lakeshore). It is a *mixt natural reservation*: botanical, geological, landscape-wise, and is of *national interest* according to the I.U.C.N. system; the reservation belongs to the 4<sup>th</sup> category, meaning it is a protected natural area which requires active intervention for the conservation of its natural and esthetic values and is part of Natura 2000 project, region number 7 center.
- Tinovului Mohoș Peat Bog (G2) which totaled 22.25 points, registered significant points in every category: scientific value, landscape and esthetic value, ecologic, social-economic values, only a bit less in educational value or cultural-historic values due to the fact that it received minimal points for archeological importance (the presence of signs of former settlements or plants and animals), or religious relevance or relevance for local traditions and habits. It is the most representative geomorphosite from a scientific point of view (geologic, volcanologic, botanical, zoological) and landscape-wise due to the presence of the peat bog which houses a special flora

(several rare and endemic plants from the last glacial period: like carnivorous plants) and special fauna, and more than 15 lakes. It is a *Natural Botanic Reservation of national interest*, according to the I.U.C.N. system; the reservation belongs to the 4<sup>th</sup> category meaning it is a protected natural area which requires active intervention for the conservation of its natural and esthetic values and is part of Natura 2000 project, region number 7 center.

- In the third place according to the awarded points we have the Piatra Șoimilor geomorphosite from Băile Tușnad Resort (G3), a volcanic neck which rises above the spa resort with more than 200 meters. It is a natural, geological and botanical reservation which covers a surface of 1 hectare, which offers a magnificent overview on the Olt River's defile and Băile Tușnad spa resort itself.
- The Monk's Bath and the volcanic cone from Șumuleu (G4) received the highest scores regarding their cultural and touristic values, having in total 20.5 points. Aside their scientific value, presented by the representativeness of the volcanic cone and of the post volcanic activities manifesting at the foot of the cone, in the case of the Monk's Bath the total value of the hydrogeomorphosite is significantly influenced by the religious Romano-Catholic pilgrimage, which is held in the saddle between the Șumuleu Mare (1033m) peak and the Șumuleu Mic (834 m) peak, whose history dates back to 1567, event held yearly for Pentecost.
- „Nyir” (Birch tree) Bath and mofetta (G5) is renowned for its scientific value, respectively due to the post volcanic activity (mofetta type) and by the existence of mineral water springs. This folk bath was renewed in 2001 with public volunteer work of the community from Lăzărești, to create an objective of local and regional interest. This hydrogeomorphosite totaled 15.25 points.
- The final scores of the geomorphosites from the Harghita Mountains (see Table Nr.5) demonstrate that the accessible geomorphosites with ecologic and scientific value present a significantly higher score in comparison with the difficult to access geomorphosites, even with lower restrictive values and of higher touristic interest.

## BIBLIOGRAPHY

1. Amalia, Sz. (1963), *Studiu petrografic asupra rocilor andezitice din carierele din valea Oltului între Tuşnad și Malnaș*, Stud. și cerc. geol. Acad. R.P.R., VIII. 2.
2. Airinie, Șt., Pricăjan, A.(1972) *Corelații între structura geologică adâncă și aureola mofetică din Județul Harghita, cu privire la zonele de apariție a apelor minerale carbogazoase*, Stud. și cerc. g., g., g., ser. Geol., 17. 2.
3. **Bálint – Bálint, L.**, Irimuș, I.A. Crișan, H-F , Cioban T., Dombay, Șt., (2016) *Mofettas in the Mount Ciomadu volcanic mountain area and the balneary tourism* 16th International Multidisciplinary Scientific Conference, Book 5 Ecology, Economics, Education and Legislation, Conference Proceedings/Vol.I, Environmental Legislation, Multilateral Relations & Funding Opportunities p.449 - 454. Published by STEF92 Technology Ltd 51 "Alexander Malinov", Sofia, Bulgaria, ISSN 1314-2704/ ISBN 978-619-7105-65-0 /DOI:10.5593/sgem 2016B51.
4. **Bálint – Bálint L.** (2012), *Potențialul ecoturistic a Tinovului Mohoș*, Lucrare de disertație masterat, Universitatea Babeș-Bolyai Cluj-Napoca, Facultatea de Geografie, Cluj-Napoca.
5. **Bálint – Bálint L.**(2009) *Potențialul turistic al satului Lăzărești*, Lucrare de licență, Universitatea Babeș-Bolyai Cluj-Napoca, Facultatea de Geografie
6. Berszán J., Jánosi Cs., Kincsó, J., Kristály F., Éva, P., Szakáll S., Ütő G., (2009) *Székegyföld borvizei*, Polgár Társ Alapítvány és a Csiki Termesztjáró Egyesület, Csikszereda
7. Bruschi, Viola Maria, Cendrero, A.(2005), *Geosite Evaluation: Can We Measure Intangible Values? II Quaternario, Geomorphological Sites an Geodiversity*, Vol.18(1) 2005,p.293-306.
8. Carveni, P., Benfatto, S.,Salleo Puntillo (2008), *I Vulcano di Fangodel bassoversantesud-occidentale dell' Etna*, p.241-249. Vol. Geologia e turismo.Beni geologici e geodiversita. Oratorio s.Filippo Neri, Bologna.
9. Chabot, G (1966), *Géographie régionale de la France*, Paris, Masson, 1966, 434 p.
10. Ciangă, N., (1997), *Turismul în Carpații Orientali Studiu de geografie umană* Editura Presa Universitară Clujeană, Cluj-Napoca.
11. Cioban, T.D., Irimuș, Ioan-Aurel, Vescan, I., **Bálint-Bálint, L.**, Crisan, H.F. (2016), *The risk associated with hydrocarbons pollution site lacated on the Târnava Mare river. Case study.*. 16th International Multidisciplinary Scientific GeoConference, Book 5 Ecology, Economics, Education and Legislation, Conference Proceedings/ Vol. I, Environmental Legislation, Multilateral Relations & Funding Opportunities, p.995-1002. Published by STEF92 Technology Ltd 51"Alexander Malinov",Sofia, Bulgaria, ISSN 1314-2704/ ISBN 978-619-7105-65-0 /DOI :10.5593/ sgem 2016B51. / Accession Number: WOS:000395499800126.

12. Cocean, Gabriela (2011) *Munții Trascău. Relief, Geomorfosituri, Turism*, Editura Presa Universitară Clujeană.
13. Cocean, P., Niță, A., Dombay, St. (2013) *Județul Harghita*, Editura Academiei Române
14. Cocean, P., (2010) *Patrimoniul turistic al României*, Presa Universitară Clujeană
15. Cocean, P., Vlăsceanu, Gh., Negoescu, B., (2005) *Geografia Generală a Turismului*, Ed. Meteor Press.
16. Cocean, P. (1984), *Potențialul turistic al carstului din Munții Apuseni*. Editura Academiei București.
17. Cociașu, E., (1970) *Tratamentul hidromineral în bolile interne*, Editura Medicală, București.
18. Comănescu, L., Nedelea, Al., Dobre, R., (2009), *Inventing and evaluation of geomorphosites in the Bucegi Mountains*, Forum Geografic, Studii și cercetări de geografie și protecția mediului, anul 8, nr. 8, pg. 38-43, Craiova
19. Comănescu, L., Dobre, R., (2009), *Inventing, Evaluating and Tourism Valuating the Geomorphosites from the Central Sector of the Ceahlău National Park*, GeoJournal of Tourism and Geosites Year II, no. I., Vol. 3, Pag. 86-96.
20. Comănescu, L., Ielenicz, M., Nedelea, Al. (2010) *Relieful și valorificarea lui în turism*. Editura Ars Docendi, București,
21. Coratza, Paola , Giusti, Cecilia (2005), *Methodological Proposal for the Assessment of the Scientific Quality of Geomorphosites. II Quaternario, Geomorphological Sites an Geodiversity*, Vol.18(1) 2005,p.307-314.
22. Constantinescu, R., Thouret, J.C., Sandri, L., Irimuș, Ioan-Aurel, Ștefănescu, R. (2012), *BET\_VH probabilistic assessment of pyroclastic flow hazard at El Misti volcano, South Peru, based on geological record and numerical simulations with TITAN2D*. Vol.14, EGU2012-8997-1 Geophysical Research Abstracts. Editura European Geosciences Union General Assembly, <http://meetingorganizer.copernicus.org/on-line /EGU 2012, session/9260/ISI>.
23. Constantinescu R., Thouret J.C., Irimuș, I.A. (2011) *Computer modeling as tool for volcanic hazards assessment: an example of pyroclastic flow modeling at El Misti volcano, Southern Peru*. Rev. Geographia technical, 2/2011: p.1 -14, ISSN 2065-4421, Cluj-Napoca.
24. Crisan, H.F, Irimuș, Ioan -Aurel, Peteley, A., **Balint-Balint, L.**, Cioban, T.D., Dombay, St. (2016), *Tourism valorification on geomorphosistems Karst in Surduc- Munticelu*. Book Group Author(s): ECOLOGY, ECONOMICS, EDUCATION AND LEGISLATION CONFERENCE PROCEEDINGS, SGEM 2016, VOL I Book Series: International Multidisciplinary Scientific GeoConference-SGEM Pages: 771-777. Published: 2016. Accession Number: WOS: 000391519100103.



25. Crișan, H-F., Irimuș, Ioan-Aurel, Hirlav, C., Peteley, A.; Nita, A.(2015): *Geomorphosites in Haghimaș Mountains*. SGEM, ECOLOGY, ECONOMICS, EDUCATION AND LEGISLATION, VOL II Book Series Title: International Multidisciplinary Scientific Geo Conference-SGEM, Pages: 257 – 263; Published: 2015. Accession Number: WOS:000370814500034.
26. Crișan, Hunor-Flaviu, Irimuș, Ioan-Aurel, Peteley, A., **Bálint - Bálint, L**, Mara, V.(2015), Book Group Author(s): *Karst Geomorphosites from Giurgeu Mountains (Romania)*.SGEM ECOLOGY, ECONOMICS, EDUCATION AND LEGISLATION, VOL II .Book Series Title: International Multidisciplinary Scientific GeoConference - SGEM Pages 279-286 . Accession Number: WOS:000370814500037.
27. Coteș P., (1973) *Geomorfologia României*,Ed. Tehnică, București.
28. Danci, I., Irimuș, I.A, Vieru, Ioana, Toma, Bianca (2010), *Valorificarea turistică a geomorfositurilor în aria metropolitană clujeană*. Vol.III International Conference The Role Of Tourism in Territorial Development, p. 81-87, ISSN 2068-9578, Editura Presa Universitară Clujeană.
29. Dombay, I Magyari-Sáska Zs., László P.S., (2008) *Ökoturizmus*, Ed. Presa Universitară Clujeană
30. Dombay, I, (2007 ) *A turizmus földrajza*, Ed. Presa Universitară Clujeană
31. Erdeli,G., Istrate, I., (1996), *Potențialul turistic al României*. Editura Universității București.
32. Grandgirard, V., (1999) *L'evaluation des geotopes*, Geologia Insubrica, nr.4, pg. 59-66
33. Grandgirard, V., (1997) *Geomorphologie, protection de la nature et gestion du paysage*, These de doctorat, Universite de Fribourg, faculte des sciences
34. Grandgirard, V., (1995) *Methode pour la realisation d'un inventaire de geotopes geomorphologiques*, În UKPIK, Cahiers de l'Institut de Geographie de l'Universite de Fribourg, 10, pg. 121-137.
35. Iatu, C.(2017).*Introducere în Geografia Umană* (by Bailly, A., Beguin, H., Scariati, R , 2016. Editura Armand Colin, Franța)- traducere.Editura Univ Al.I.Cuza, Iași.
36. Jakab K., (1974) *Hargita megye természetes gyógytényezői*, Tipografia Miercurea-Ciuc
37. Hose, T.A (2000), *European Geotourism – Geological Interpretation and Geoconservation Promotion for Tourists*. In Barrentino, D., Wimbleton, W.A.P., Gallego, E (editors), *Geological Heritage: Its Conservation and Management*, Madrid: Sociedad Geologica de Espana/Instituto Tecnológico GeoMinero de Espana/ProGEO, p.127-146.
38. Hose, T.A (1996), *Geotourism, or can tourist become casual rock hounds?* In Bennett, M.R (Editor), *Geology on your doorstep:the role of urban geology in Earth Heritage Conservation*, London, Geological Society, p.207-228.

39. Hooke, J. M. (1994), *Strategies for conserving and sustaining dynamic geomorphological sites*, In O'Halloran D. et al. (eds.), *Geological and Landscape Conservation*, Geological Society, pg. 191-195, Londra
40. Ilieș, Dorina, Josan, N.(2009),*Geomorfosituri și geopeisaje*.Editura Universității din Oradea.
41. Irimia, D. N. (2014) *Valorificarea turistică a geomorfositurilor din Subcarpații Buzăului*, Editura Risoprint, Cluj-Napoca
42. Irimuș, Ioan-Aurel, **Bălint-Bălint, L.**, Dombay, St., Crișan, H.F., Magyari-Saska, Zs. (2015), *Classification and Evaluation Criteria for Volcanic Geomorphosites in Harghita Mountains*. Book Group Author(s): SGEM : SCIENCE AND TECHNOLOGIES IN GEOLOGY, EXPLORATION AND MINING,VOL I, Book Series Title: International Multidisciplinary Scientific GeoConference-SGEM; Pages: 77-84; Published: 2015; Conference Title:15th International Multidisciplinary Scientific Geoconference (SGEM). Accession Number: WOS:000371662300010.
43. Irimuș, Ioan-Aurel, Toma, Bianca; Petrea, Danut; Ciobanu, T., Togănel, C. (2014) *Vulnerability of diapiric regions under the impact of anthropic activities. Case studies in Zakarpattia (UA) and the Transylvania Depression (RO)*. Book Group Author(s): SGEM Conference: 14th International Multidisciplinary Scientific Geoconference (SGEM). GEOCONFERENCE ON ECOLOGY, ECONOMICS, EDUCATION AND LEGISLATION, VOL II Book Series: International Multidisciplinary Scientific GeoConference-SGEM Pages: 819-829. Published: 2014. Accession Number: WOS:000370816800107.
44. Irimuș, I.A, Irimia, D.N (2014), *The rupestrian places of Alunișu – possibly touristic geomorphological sites*. Rev.Studia Universitas Babes - Bolyai, Geographia, vol.60(LX), nr.1/2014, p.27-36, ISSN 1221-079X, Editura Cluj University Press.
45. Irimuș, I.A, Irimia, D.N (2012), *The Impact of Natural Hazards over Touristic valorification of Geomorphological Sites from Buzau Subcarpathians*. Rev.Riscuri și Catastrofe. Editor: V.Sorocovschi, Editura Casa Cărții de Știință, Cluj-Napoca, ISSN 1584-5273. An XI, vol.11, nr.2/2012, p.84-92.
46. Irimuș, I.A., Bianca, Toma (2012), *The Promotion of Geomorphosites on Salt from Sovata-Praid and Turda using Cultural-Scientific Tourism*. Rev.de Geomorfologie,vol.14,p.103-113/ISSN 1453-5068.
47. Irimuș, I.A, Petrea, D., Vescan, I., Bianca Toma, Ioana Vieru (2011), *Vulnerabilityof Touristic Geomorphosites in Transylvanian Saliferous Areas (Romania)*.Rev.GeoJournal of Tourism and Geosites, Year IV, 2011/no.2,vol.8, ISSN 2065-0817/ E-ISSN 2065-1198, p.212-219,Oradea-Gdansk.
48. Irimuș, I.A (2010), *Relieful. Potențial și valorificare turistică*. Editura Risoprint, Cluj-Napoca.
49. Irimuș, I.A., Pop, O., Petrea, D., Rus, I., Pop, C., Abrudan,I. (2010), *Geomorfositul „Grădina Zmeilor” .Propuneri de conservare și valorificare turistică*. Vol.Geography within the Context of Contemporary Development, p.455-459, ISSN:1843-2158, Editura Presa Universitară Clujeană, Cluj - Napoca..

50. Irimuş, Ioan-Aurel, Petrea, D., Surdeanu, V., Fodorean, Fl., Pop, O. (2009), *Transilvanian Paleo-Landscape Reconstruction of Roman Roads in Dacia Porolissensis*. Vol. Ol' Man River: Geo-Archaeological Aspects of Rivers and River Plains. Book Series: Archaeological Reports Ghent University. Volume: 5. Pages: 483-496. Accession Number: WOS:000319467200030 .
51. Irimuş, I.A., Neagu, L., Cristea, C., Petrea, D. (2009), *La promotion touristique et valorisation des géomorphosites dans l'aire salifères de l'anticlinal Sărăţel – Jabeşiţa - Sovata – Praid*. Colloque international de Géomorphologie - Géomorphosites 2009: imagerie, inventaire, mise en valeur et vulgarisation du dans les Monts Apuseni (Roumanie). Colloque international de Géomorphologie - Géomorphosites 2009: imagerie, inventaire, mise en valeur et vulgarisation du patrimoine géomorphologique, Univ. Paris - Sorbonne (France) - 2009, Abstract, p.148.
52. Irimuş, I.A., Fodorean Fl., Surdeanu, V., Petrea D., Rus, I., Buzilă L. (2008), *The Reconstruction of the Paleolandscape of Geosits From The North Western Limes of Porolissensis Dacia.*, Vol."Landscape Evolution & Geoarcheology, Abstract Book, p.35-37, Gr.
53. Irimuş, I.A., Vescan I., Man T. (2005), *Tehnici de cartografiere, monitoring și analiză GIS, Cap. 1-6 , p.9 -152*, Editura Casa Cărții de Știință, Cluj-Napoca, ISBN 973-686-809-5, p.244
54. Irimuş I.A (2004), *Potențialul geomorfologic și riscurile geomorfice ale regiunii Tășnad*, cap.I., p.4-28. Strategia de dezvoltare economico-socială a Microregiunii Tășnad (editor coordonator P.Cocean). Editată de Presa Universitară Clujeană și Asociația civilă pentru dezvoltarea comunitară Tășnad, p.73.
55. Irimuş I. A., (2003) *Geografia Fizică a României*, Ed. Casa Cărții de Știință, Cluj-Napoca.
56. Irimuş I. A., (1996) *Cartografiere geomorfologică*, Editura Focul Viu, Cluj-Napoca
57. Jánosi Cs., Berszán J., Éva, P. (2013) *Székelyföld fürdői*, Csiki Természetjáró és Természetvédő Egyesület, Csíkszereda
58. Jánosi Cs., Éva, P, Sólyom L., (2002) *Az Olt*, Alutus, Csíkszereda
59. Kisgyörgy Z., Kristó A., (1978) *România ásványvizei*, Editura Științifică și Enciclopedică, București
60. Mac, I. (1996) *Geomorfosfera și geomorfosistemele*, Presa Universitară Clujeană, Cluj-Napoca
61. Mac, I. Irimuş I.A. (1991) *Zone succetibile fenomenelor geomorfologice în lungul căii ferate Apahida – C.Turzii*. Studia UBB, nr.1/1991.
62. Muntele, I., Iatu, C .(2006), *Geografia turismului. Concepte, metode și forme de manifestare spațio-temporală*. Editura Sedcom Libris, Iași.

63. Neacșu, N. (2000), *Turism și dezvoltare durabilă*, Editura Expert, București.
64. Neagu Luminița, Irimuș, I.A, Toma Bianca, Vieru Ioana, Danci, I., (2010), *Le Tourisme culturel et religieux dans le bassin morphohydrographique Gurghiu*. Vol. III International Conference The Role Of Tourism in Territorial Development, p. 232-241, ISSN 2068-9578, Editura Presa Universitară Clujeană
65. Ollier, Cl. (1969), *Volcanoes*, The MIT Press, Cambridge, Massachusetts and London
66. Orbán B., (1870), *Descrierea Ținutului Secuilor*, Pesta, prima ediție din Ardeal, 1991-1996
67. Panizza, M., Piacente, Sandra (2008), *Geomorphosites an Geotourism*. Rev. Geogr. Academica, 2,1.
68. Panizza, M., Pignone, R. (2008), *Geologia e turismo. Beni geologici e geodiversita*. Oratorio s.Filippo Neri, Bologna.
69. Panizza, M., Piacente, Sandra (1993), *Geomorphological Assets Evaluation*. In Zeitschr für Geomorphologie, N.F, Bd 87, p.13-18.
70. Pécskay, Z. Szakács, S. Seghedi, I. Karátson, D. (1992) *Új adatok a Kakukkhegy és szomszédsága (Dél-Hargita, Románia) értelmezéséhez* Földt. Közlöny, 122 2-4, Budapest
71. Pereira, P., Pereira, D., Caetano, A.M.I (2007), *Geomorphosites Assessment in Montesinho Natural Park (Portugal)*, Geographica Helvetica 62,,3,p.159-168.
72. Petrea, D., Irimuș, I.A., Petrea Rodica, Rus, I. (2009), *Valorisation touristiques des géomorphosites. Colloque international de Géomorphologie - Géomorphosites 2009: imagerie, inventaire, mise en valeur et vulgarisation du patrimoine géomorphologique*, Université Paris - Sorbonne (France) - 2009, Abstract, p.116.
73. Petrea, D., Rodica, P.(2001), *Turismul rural*, Editura Presa Universitară Clujeană, Cluj-Napoca.
74. Pilbáth G. A., Pál Sz., (2005) *Ghid ecoturistic, Ariile protejate în regiunea Ciomad-Balványos*
75. Popa, I. (2015) *Vulnerability to pollution of termomineral sources in Băile Tușnad area*, AES Bioflux, Volume 7, Issue 2
76. Pop, Gr. (2006) *Carpații și Subcarpații României*, Ed. Presa Universitară Clujeană, Cluj-Napoca.
77. Pop, O., Hodor, N., Surdeanu, V., Irimuș, I.A. (2010), *Conséquences de l'instabilité morphodynamique liée à l'exploitation du soufre dans le massif volcanique du Călimani (Roumanie)*. Revue Géographique de l'Est, vol.49/1/2009, ISSN 2108-6478/ ISSN 0035-3213, p.1-17.
78. Pop, O., Guitton, M., Surdeanu, V., Irimuș, I.A. (2009), *Inventaire des sentiers de randonnée érodés dans le massif du Sancy (Massif Central Français)*.

- Coll.international de Géomorphologie–Géomorphosites 2009: imagerie, inventaire, mise en valeur et vulgarisation du patrimoine géomorphologique, Univ.Paris-Sorbonne (Fr.)/2009, p.152patrimoine géomorphologique, Université Paris - Sorbonne (France) - 2009,Abstract, p.113.
79. Posea Gr., Popescu, N., Ielenicz, M., (1974) *Relieful României*, Edit. Științ., București
  80. Posea Gr., (2005) *Geomorfologia României: relieful, tipuri, geneză, evoluție, regionale*, Editura Fundației România de mâine, București
  81. Posea Gr., (2001) *Vulcanismul și relieful vulcanic – hazarde, riscuri, dezastre – Relieful vulcanic din România*, Editura Fundației România de mâine, București
  82. Posea, Gr.(2012), *Relieful – resursă de bază a turismului.Geomorfodiversitate și geomorfosituri*. Editura Fundației România de Mâine, București.
  83. Pralong, J.P (2005), *A Method for Assessing The Tourist Potential and Use of Geomorphological Sites. Geomorphologie. Relief, processus, environment 3/2005*, p.189-196.
  84. Rădulescu D.P., Peltz, S. Stanciu C., (1973) *Neogene volcanism in the East-Carpathians*, Guide to Excursion, București.
  85. Reynard, E., Paola Coratza, Geraldine Regolini-Bissig (2009), *Geomorphosites*. Verlag Dr.Friedrich Pfeil, Munchen, 2009.
  86. Reynard, E., (2009), *The Assessment of Geomorphosites*. In Reynard,E.,Coratza, P., Regolini-Bissig,G, Geomorphosites, Verlag Dr.Friedrich Pfeil, Munchen,p.63-71.
  87. Reynard, E., (2008), *Scientific Research and Tourist Promotion Geomorphological Heritage*. In Geogr.Fis.Dinam.Quat.31, p.225-230.
  88. Reynard, E., (2005), *Geomorphosites et paysages*. In *Geomorphologie. Relief, processus, environment 3/2005*, p.197-208.
  89. Rittmann, A., (1973) *Vulcanii și activitatea lor*. Edit. Tehn., București
  90. Rivas V., Rix K., Frances E., Cendrero A., Brunsden, D., (1997) *Geomorphological indicators for environmental impact assessment: consumable, and non-consumable geomorphological resources*, *Geomorphology*, nr. 18, pg. 169-182.
  91. Rus, I., Petrea, D., Glodariu, I, Surdeanu,V., Irimuş, I.A., Mateescu, R., Buzilă , L. (2008), *Natural and Cultural Landscape in Sarmizegetusa Regia (Dacia)*, Vol. Landscape Evolution & Geoarcheology, Abstract Book, p. 94-95, Greece
  92. Szabó Á., (1978) *Ape și gaze radioactive în R.S. România*, Editura Dacia, Cluj-Napoca
  93. Szakács, A., Seghedi, I., Pécskay Z., Mirea V. (2015) *Eruptive history of a low-frequency and low-output rate Pleistocene volcano, Ciomadul, South Harghita Mts., Romania* Bull Volcanol, DOI 10.1007/s00445-014-0894-7, Springer-Verlag Berlin Heidelberg

94. Szakács, A., Krézsek, C.(2006),*Volcano–basement interaction in the Eastern Carpathians: explaining unusual tectonic features in the Eastern Transylvanian Basin, Romania*. Journal of Volcanology and Geothermal Research,vol. 158, p. 6 –20.
95. Szakács, A., Seghedi, I. (2000), *Large volume volcanic debris avalanche in the East Carpathians, Romania*. In : Leyrit H., Montenat C., Volcaniclastic Rocks from magmas to sediments, Gordon and Breach Science Publishers, Amsterdam, p. 131-150.
96. Serrano, E., Gonzales Trueba J.J. (2005), *Assessment of Geomorphosites in Natural Protected Areas: the Picos de Europa National Park (Spain), Geomorphologie. Relief, processus, environment* 3/2005, p.197-208.
97. Schreiber,W.E. (1994) *Munții Harghita, Studiu Geomorfologic*, Ed. Academiei Romane, Bucuresti
98. Schreiber,W.E (1979) *Munții Harghita, Geologie și Geomorfologie*, Ghidul excursiilor, Brașov.
99. Toma Bianca, Irimuș, I.A., (2013), *Therapeutic and Tourism Recovery of Microclimate from Praid and Turda Salt Mine*. Rev. Studia Universitas Babeș-Bolyai,Geographia, vol.58(LVIII), nr.1/2013, p.75-85, ISSN 1221-079X, Editura Cluj University Press.
100. Toma Bianca, Irimuș, I. A., D. Petrea, Gh. Roșian (2013), *Assessment of the geomorphosite on salt from Ocna Sibiului (Transilvanyan Basin, România)*.Vol.8th IAG International Conference on Geomorphology, S15B/ Geomorphosites (IAG-WG) including Geoparks and WHS, p.539-559, Paris, 27-31 august 2013, France/ www.geomorphology - iag- Paris.
101. Toma Bianca (2012) *Geomorfositurile pe sare din depresiunea Transilvaniei și valorificarea lor turistică*, Teză de doctorat. Biblioteca Facultății de Geografie.
102. Toma Bianca, Irimuș, I.A., Petrea, D. (2012), *The promotion of geomorphosites on salt from Sovata-Praid and Turda using cultural and scientific tourism*. Vol.14, EGU2012-12878 Geophysical Research Abstracts. Editura European Geosciences Union General Assembly, [http://meetingorganizer.copernicus.org/on-line/EGU2012, session/9260/ISI.,fulltext](http://meetingorganizer.copernicus.org/on-line/EGU2012/session/9260/ISI.,fulltext) Article in The Smithsonian/NASA Astrophysics Data System, Vienna, Austria, p.12878.
103. Toma Bianca, Irimuș, I.A, Danci, I., Vieru Ioana, Neagu Luminița (2010), *Saliferous Geomorphosites from East-Transylvanian Diapire Folds and Their Touristic Value*. III International Conference The Role Of Tourism in Territorial Development, p. 349-356, ISSN 2068-9578, Editura Presa Universitară Clujeană.
104. Torjai R. Z., (1998) *Erdély hegyei, Vol 2. Harghita hegység – Turisztikai kalauz*, Pallas Akademia, Csikszereda

105. Treiber, I., (1956) *Cercetări geologice în Munții Cășimani și Harghita* D. S. Șed., Com. Geol., XL (1952-53), București
106. Vasilescu Al., (1964) *Cercetări geologice și petrografice în partea de sud-est a munților Harghita*, D. S. Com. Geol. L/2 (1962-63), București
107. Vofkori L., (2007) *Utazások Székelyföldön*, Pro Print Kiadó, Csikszereda
108. Vofkori L., (1998) *Székelyföld útikönyve I., II.*, Cartographia, Budapest
109. \*\*\* (2017) Asociația Pro „Szent Anna” – Dósa Levente
110. \*\*\* (2016), Raport anual. Consiliul Local Băile Tușnad.
111. \*\*\* (2017), Raport anual. Consiliul Local Cozmeni
112. \*\*\* (2017), Ecos Club SRL, Kerezsi László - custodele rezervației
113. \*\*\* Planul de Management al Rezervației Naturale Lacul Sfânta Ana și Tinovul Mohoș
114. \*\*\* Planul de Management al Rezervației Naturale Piatra Șoimilor-Băile Tușnad
115. \*\*\* (2017) Vancsa, G., Medic balnelog
116. \*\*\* [www.mohoș.ro](http://www.mohoș.ro) – Mohoș are nevoie de tine! - Planul de acțiune pentru salvarea vegetației ocrotite aflate în pericol

## Ph.D. Thesys Content

<b>1. Introduction</b> .....	4
<b>2. Methodological aspects of the study</b> .....	8
2.1. Geomorphosites in the geographic literature.....	8
2.2. Methodology in researching geomorphosites.....	11
2.2.1. Methodology proposed by European geomorphological schools .....	13
2.2.2. Methodology proposed by Romania geomorphological schools.....	19
2.2.3. Evaluation chart – identification algorithm of geomorphosites.....	23
2.3. Brief research history of geomorphosites.....	30
<b>3. Morphology of Harghita Mountains</b> .....	33
3.1. Paleogeomorphology of Harghita Mountains .....	33
3.1.1. Volcanic activity’s premises.....	36
3.1.2. Volcanic activity and the resulted relief.....	37
3.1.2.1. Classification of mineral springs and their curative powers.....	46
3.1.3. Present volcanic relief of the Harghita Mountains.....	47
3.1.3.1. Morphology and hydrology of Harghita Mountains.....	48
3.2. Modeling of the Hargitan volcanic relief.....	52
3.2.1. River modeling .....	55
3.2.2 Present geomorphologic processes and slope evolution .....	56
3.2.3. Biologic and anthropic modeling .....	58
<b>4. Volcanic structures</b> .....	61
4.1. Volcanic cones.....	61
4.1.1. Răchitiș volcanic cone .....	62
4.1.2. Ostorog volcanic cone .....	62
4.1.3. Muntele Mic volcanic cone .....	62
4.1.4. Harghita volcanic cone .....	63
4.1.5. Arotaș volcanic cone .....	64
4.1.6. Luci volcanic cone .....	65



4.1.7. Cucu volcanic cone .....	65
4.1.8. Pilișca volcanic cone .....	66
4.1.9. Ciomadu volcanic cone .....	66
4.1.10. Murgu volcanic cone .....	71
4.2. Volcanic plateaus .....	71
4.3. Rezidual volcanic forms (necks, dykes).....	73
<b>5. Evaluating the volcanic geomorphosites in the Harghita Mountains .....</b>	<b>79</b>
5.1. Classification criteria for volcanic geomorphosites .....	79
5.2. Volcanic geomorphosite typology .....	81
5.2.1. Volcanic geomorphosites .....	83
5.2.2. Volcanic geomorphohydrosites .....	89
5.2.3. Volcanic hydrogeomorphosites .....	92
<b>6. Touristic grading and marketing of the geomorphosites.....</b>	<b>97</b>
6.1. The volcanic geomorphohydrosite Lacul Saint Ana Lake.....	99
6.2. The volcanic geomorphohydrosite Tinovul Mohoș Peat Bog.....	105
6.3. Volcanic geomorphosite the Piatra Șoimilor neck .....	109
6.4. The volcanic hydrogeomorphosite Baia Călugărilor.....	113
6.5. The volcanic hydrogeomorphosite “Nyír” Bath and Lăzărești mofetta ...	118
6.6. Volcanic geomorphosite Haromul Mare and Haromul Mic .....	124
6.7. Volcanic geomorphosite Jigodin – Șumuleu dyke .....	128
6.8. Geomorphosite Piatra Șomko .....	131
7. Conclusions.....	135
8. Appendix .....	138
9. Bibliography.....	179